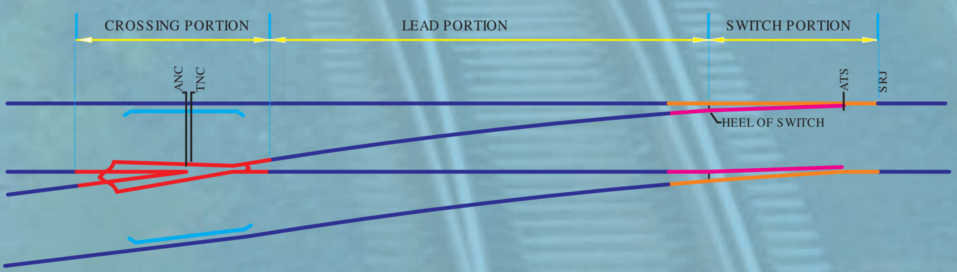
TURNOUT

Laying • Inspection • Maintenance



November 2021

INDIAN RAILWAYS INSTITUTE OF CIVIL ENGINEERING

PUNE - 411001.

Published By
Indian Railways Institute of Civil Engg.
11-A, South Main Road, Koregaon Park, Pune 411 001.

FIRST EDITION
SEPTEMBER 2014

SECOND EDITION
NOVEMBER 2018

THIRD EDITION
NOVEMBER 2021

Price ₹ 100/-

Designed by
KIRAN PRINTERS
Pune

Printed by
KIRAN PRINTERS
Pune

ज्ञान ज्योति से मार्गदर्शन

To Beam As A Beacon of Knowledge

TURN OUT

Laying ● Inspection ● Maintenance

November 2021

**INDIAN RAILWAYS INSTITUTE OF CIVIL ENGINEERING,
PUNE - 411001.**

Foreword to Third Revised Edition

Most of the turnouts on Indian Railways in last two decades have been changed to Curved switch on PSC sleepers. Laying of thick web switch turnouts is also being done in a big way in Indian Railways. Turnout is a complicated structure and when laid in curves needs more technical knowhow for laying and maintenance. This book was originally published in September 2014 by Shri. Manoj Arora the then, Sr. Professor / Track at IRICEN and reprinted in Jan 2016. 2nd revised edition was published in 2018 incorporating IRPWM correction slips up to that time.

This publication i.e. 3rd revised edition is an updated version incorporating all provisions of new IRPWM 2020 and with detailed explanation of sleeper spacing as per RDSO drawing and also when turnout takes off from curve both for ordinary overriding switch and thick web switch turnouts. Necessary tables have also been updated for ordinary switch turnout and new tables given for thick web switch turnout for the benefit of field people for reference while laying and maintenance of fan-shaped turnout. Updating of book has been done by Shri R K Bajpai, Sr Professor Track-1, IRICEN.

I hope that the book will be found useful by the field engineers involved in laying and maintenance of point and crossings.

The suggestions for improvement are welcome.

Pune
November 2021

Ashok Kumar
Director General
IRICEN, Pune

Foreword to Second Edition

Most of the turnouts on main line and passenger loops on Indian Railways in last two decades have been changed to Curved switch on PSC sleepers. Turnouts have always been considered complicated structure. This book was originally published in September 2014 by Shri. Manoj Arora the then, Sr. Professor / Track at IRICEN and reprinted in Jan 2016.

This publication i.e. 2nd revised edition is an updated version incorporating latest correction slips on various provisions of IRPWM, incorporating joint procedure of inspection with signalling department and new chapter on deep screening of Turnout. Updating of book has been done by Shri Manoj Arora CTE W Rly, Shri Anil Choudhary Sr. Professor/IRICEN & Shri N K Mishra Associate Professor / Track-1 / IRICEN.

I hope that the book will be found useful by the field engineers involved in laying and maintenance of point and crossings.

The suggestions for improvement are welcome.

Pune
November 2018

Ajay Goyal
Director
IRICEN, Pune.

Forward

Most of the turnouts on main line and passenger loops on Indian Railways in last two decades have been changed to curved switch on PSC sleepers. Turnouts have always been considered complicated structure. Attempts are being made to increase speed on turnouts with improved design. In order to make riding more comfortable and safe, laying and maintenance standards of turnout needs to be upgraded.

Very few books are available on turnouts. Available books being old, hence these books are not containing experience gained about turnouts over last two decades.

In this book, attempts have been made to discuss various problems being felt by field engineers. The issues related to laying and maintenance of turnouts on curve and related solutions have been discussed in detail. Ready reckoner tables and sketches have been provided for standard layouts for ease of use at field level.

This book was originally written in Hindi by Shri Manoj Arora the then, Senior Professor Track at IRICEN. This book received prestigious “Rajiv Gandhi Rashtriya Gyan Vigyan Moulik Pustak Lekhan Puraskar”. The book in translated form is presented now.

I hope field engineers and supervisors will find this book useful. Suggestions are welcome for further improvement of this book.

Vishvesh Chaube
Director
IRICEN, Pune.
September 2014

Preface

Turnout is an integral part of any track. Since it is one of the most complicated part of track structure, special care is required for its assembly, laying and maintenance. Over the last 2-3 decades, track structure on a main line track has been improved to a great extent. Almost all the tracks on Indian Railways is now with PSC sleepers. On the similar lines, almost all the turnouts on main line and passenger loops have been converted to curved switch on PSC sleeper. This upgradation have helped to improve riding on turnout. But still turnouts are most sensitive area of track. In order to cope up with the challenges of maintaining accident free track, improvement in the field of laying and maintenance of turnouts is required.

This book is a result of my 6½ yrs. of experience with IRICEN where I learnt the technicality of turnouts. This book was originally written in Hindi. With God's grace, this book in Hindi was awarded prestigious "Rajiv Gandhi Rashtriya Gyan Vigyan Moulik Pustak Lekhan Puraskar". This book is the English translation of the same book.

In this book, experiences of officers and supervisors who are dealing with track in the field have been incorporated and attempt have been made to provide practical solutions. The problems related to laying of turnouts on curve, its maintenance and speed potential have been discussed in two Chapters. The speed potential of turn in curve have also been dealt in this book.

I hope this book will be useful for field engineers and supervisors. Attempt have been made to provide useful data and sketches for the field application. It is possible that inspite of all the efforts, few mistakes may still be there in this book. Hence, the readers are requested to please communicate their suggestions to make this book further useful for field application.

Manoj Arora
Chief Engineer
(Constn. & Survey)
Western Railway

Acknowledgement

I want to communicate my sincere gratitude to Shri Vishwesh Choubey, Director IRICEN for helping me to write this book. I am thankful to Shri N. C. Sharda, Senior Professor/track IRICEN for the pains he has taken in discussing various issues related to the turnout from time to time. I also want to thank S/Shri N.R.Kale, AEN-IRICEN, J.M.Patekari, AEN-IRICEN, Sunil Pophale, SSE(Drg.)-IRICEN for helping me in arranging technical material on the subject; Shri D.S.Thomar, AIE-RDSO and Shri Kanta Prasad Yadav, SSE(P.Way)BSL for supporting me with the technical data and field experience; Shri Harish Trivedi, Tech. Asst IRICEN, Shri Nizami, SSE-IRICEN and Pradeep Tawde, Technician, IRICEN for their support. I also want to thank Shri N.K. Khare, Associate Professor, for supporting me in writing this book and proof reading.

I also want to communicate my thanks to my wife and children for supporting me to write this book. They also have been motivating me to complete this book.

Manoj Arora
Chief Engineer
(Constn. & Survey)
Western Railway

CONTENTS

CHAPTER 1

BASICS OF THE POINT AND CROSSING ASSEMBLY

1.0 Turnouts or Points & Crossings assembly: Points and crossing is also known as turnout as it turns a train out from one track to another track. Turnout is normally followed by a turn-in-curve, but sometimes there mayy not be a turn-in-curve if the turnout track goes in same alignment without changing its direction.

1.1 Important assemblies of turnouts: In order to improve the quality of maintenance of points and crossings, it is necessary to understand its assembly and other important aspects related to design. Turnout consists of mainly 3 sub-assemblies, viz.

1) Switch
2) Crossing
3) Lead

These three parts of turnout and other components of turnout are shown in (fig. 1.1). Important terms and definitions used in describing various parts of a turnout assembly are :-

1.1.1 Switch: The switch comprises of pair of tongue rails between two stock rails. Both the tongue rails are connected to each other with the help of stretcher bars, so that they are operated simultaneously. The pair of tongue rails along with attached stock rails and all other fittings is called point.

1.1.2 Right hand switch and left hand switch: Depending on the side to which a train traveling in the facing direction of the switch is diverted, the point assembly is designated as right hand or left hand switch. In order to know whether turnout is left hand or right hand one has to stand at the SRJ and look towards the turnout. If the turnout side is towards right hand, it is called right hand switch, if it is going towards left, it is called left hand switch (fig 1.2).

1.1.3 Facing and trailing point: The turnouts on which trains are to be received from SRJ side are called facing point for such

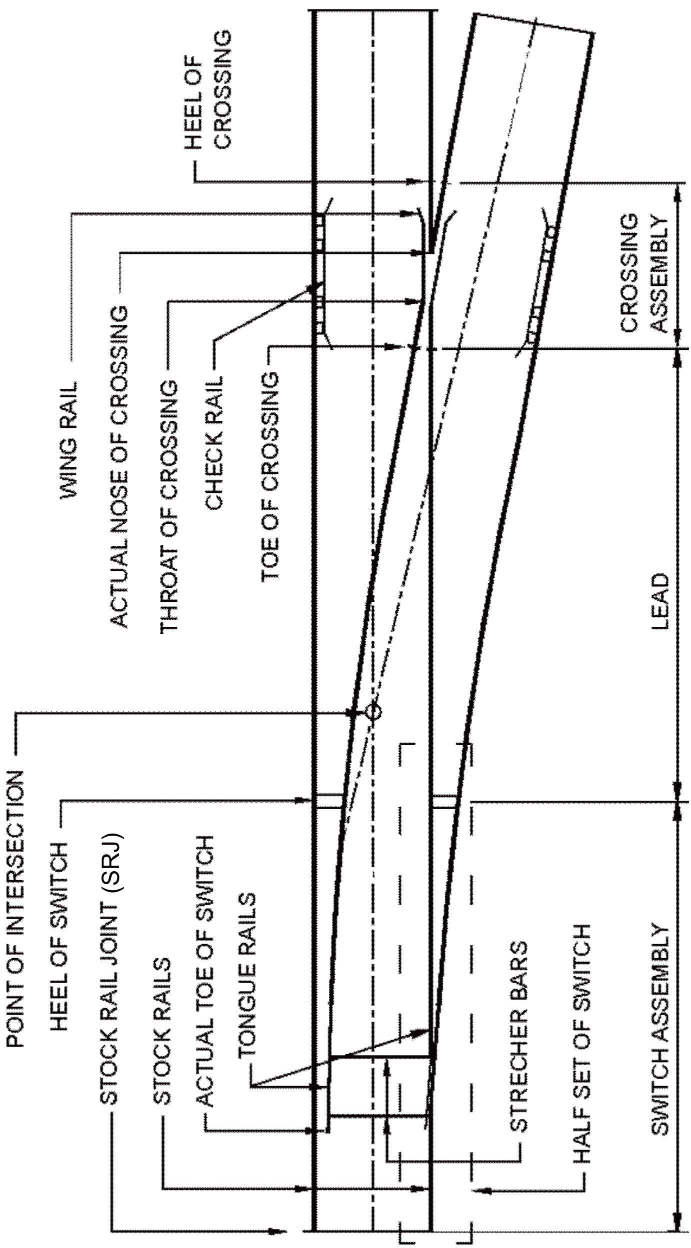


Fig. 1.1 Components of turnout

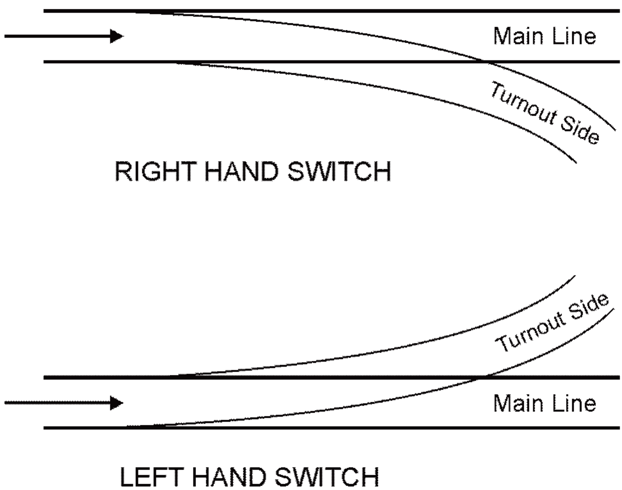


Fig. 1.2 LH and RH turnout

trains and the turnout on which trains are received from crossing side from any of the two tracks are called trailing turnout for such trains. Now a days, many loops are being converted as common loops, hence most of the turnouts pass trains in both directions.

1.1.4 Straight switch and curved switch: Straight switches have straight tongue rails. On such turnouts, vehicle will move on one straight track followed by another straight track. In case of curved switch, tongue rail is made curved. But this curve is not tangential to main line and there is no transition between straight and circular curve (fig 1.3).

1.2 Switch assembly: Important parts and terms involved in switch assembly are :-

(a) **Stock rail joint (SRJ):** is the joint at which the stock rail is joined to the rail at the approach. Both the stock rail joints of a point are kept opposite to each other (fig. 1.1).

(b) **Theoretical toe of switch (TTS):** is point of intersection of gauge line of a tongue rail at its ATS and its stock rail in closed position in case of straight switches. In case of

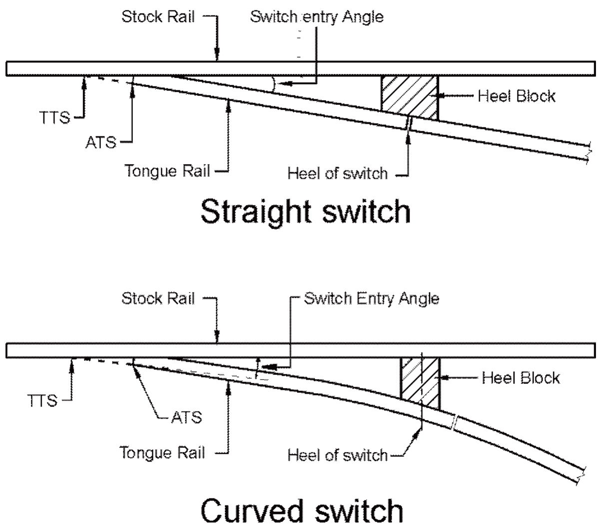


Fig. 1.3 Straight and curved switch

curved switches, it is a point of intersection of the gauge line of stock rail to imaginary tangent drawn at the actual toe of the switch (Fig. 1.3).

(c) **Actual toe of switch (ATS):** It is a point at which the tongue rail starts at the front end. It is the first tip of tongue rail visible to the eyes. At ATS, tongue rail is machined very thin and lower than stock rail. It is further provided a fillet of radius 12 or 13mm at the beginning. After fillet, top of tongue rail is provided upward slope. Tongue rail for different turnout and rail section have been given slightly different machining (fig. 1.9 and table 1.3).

(d) **Switch angle:** is the angle between gauge lines of the tongue rail and its stock rail in the closed position, in case of straight switches. In case of curved switches, it is the angle between imaginary tangent drawn to the gauge line of tongue rail at ATS and the gauge line of the stock rail. It is also called switch entry angle (SEA). (fig. 1.3)

In case of a vehicle moving towards turnout side from main line, it encounters a curve immediately after straight with out any transition curve. In case of a normal curve which is provided on plain track, it always starts with a transition curve followed by circular curve with the provision that transition curve should meet tangentially to straight as well as circular curve for smooth riding. However, on turnouts, circular curve does not meets straight tangentially, it meets at an angle i.e. switch entry angle. Hence, a jerk is felt when a vehicle passes through actual toe of switch. The amount of jerk depends upon switch entry angle. Switch entry angles for various turnouts have been given in the following table:-1.1

Table 1.1

SN	Type of switch	Gauge	Switch angle
1.	1 in 8 ½ straight	BG	1^0 - 34’ - 27”
2.	**1 in 8 ½ curved on PSC**	**BG**	**0^0 - 46’ - 59”**
3.	1 in 12 straight	BG	1^0 - 8’ - 0”
4.	1 in 12 curved (wooden/ST)	BG	0^0 - 27’ - 35”
5.	1 **in 12 curved on PSC**	**BG**	**0^0– 20’ – 00”**
6.	**1 in 16 curved on PSC**	**BG**	**0^0– 20’ – 00”**
7.	**1 in 20 curved on PSC**	**BG**	**0^0– 20’ – 00”**
8.	1 in 8 ½ straight	MG/NG	1^0 - 35’ - 30”
9.	1 in 8 ½ curved	MG	0^0 - 29’ - 14”
10.	1 in 12 straight	MG/NG	1^0 - 9’ - 38”
11.	1 in 12 partly curved	MG	0^0 - 24’ - 27”

It can be seen that SEA for turnouts on PSC sleepers have been reduced to a great extent as compared to earlier designs. This is one of the important factors for increase in speed on PSC turnouts.

(e) **Throw of switch:** Throw of switch is the distance through which a tongue rail moves at its toe from its closed position to open position. This distance is measured from the gauge line of the stock rail to inside (non gauge face) of the open tongue rail. It is measured at actual toe of switch (Fig. 1.4).

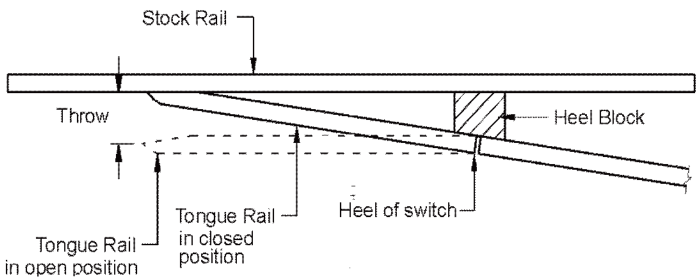


Fig. 1.4 Throw of switch

Throw of switch is decided from consideration of minimum clearance required between the back of open tongue rail and gauge face of stock rail at JOH. As per provisions of **schedule of dimensions (2004)** for BG, minimum throw of switch allowed for existing works should be 95mm, but for new works or alteration to existing works it is 115±3mm. Maintenance of proper throw of switch helps to:

1. Ensure proper bearing of closed tongue rail against stock rail.
2. Provide minimum clearance of open tongue rail required for passage of wheel flange at JOH.

Point machines provided by signaling department are designed for 143mm throw and part of the stroke is made idle to achieve the desirable throw. Normally, signaling department provide stroke of 118mm (3mm extra for ensuring reasonable tightness). Now a days, new point machines have been designed which are useful for thick web switch. This is provided with a throw of 220mm. Both the tongue rails are not moved simultaneously but the open tongue rail is moved first for 60mm followed by simultaneous movement of 100mm. Finally, initially closed tongue rail is moved for 60mm. Which makes the total throw of 160mm.

(f) Heel of switch and Heel block: Heel block is the first block from toe of switch, fixed between the tongue and the stock rail with the help of bolts (fig. 1.1).In case of loose heels, heel of switch is an imaginary point on the gauge line midway between the end of the lead rail and the tongue rail. In case of fixed heel switches, it is a point on the gauge line of tongue rail opposite the centre of the heel block.

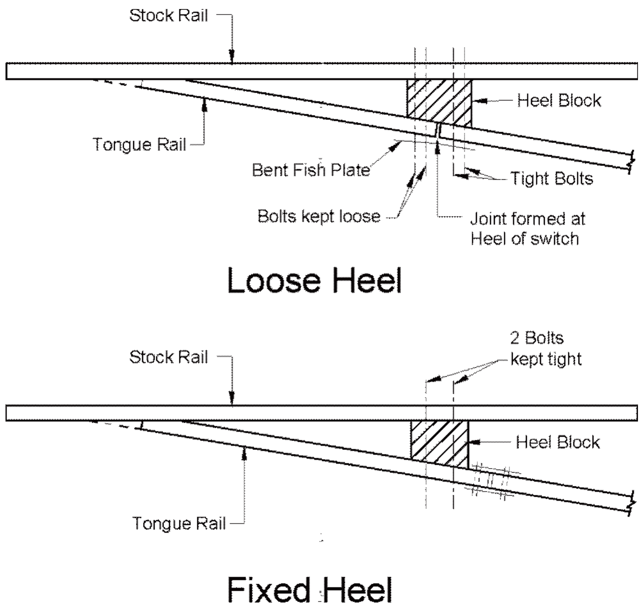


Fig. 1.5 Loose and fixed heel switch

Loose heel: When the tongue rail and lead rail form a joint at the heel of switch, it is called loose heel switch. At such loose heel switch, fish plate is bent in front half to allow rotation of tongue rail. The 2 bolts provided towards ATS are kept loose to allow rotation of tongue rails where as the other two bolts towards lead are kept tight (fig.1.5).

Fixed heel: In fixed heel switch, tongue rail extends beyond the heel and forms a joint with the lead rail. In case of fixed heel, all the bolts are kept tight. All the modern turnouts are provided with fixed heel.

(g) Heel Divergence: The heel divergence of the switch is the distance between the gauge lines of stock rail and that of tongue rail at the heel or in other words, it is the clearance between these two rails at the heel plus the width of the tongue rail head. It is measured right angle to gauge face of the stock rail (Fig. 1.6).

Table 1.2

Type of switch	Heel divergence in mm
BG 1 in 8 ½ straight	136
BG 1 in 12 straight	133
BG 1 in 8 ½ curved (PSC)	**182.5**
BG 1 in 12 curved (PSC)	**175**
MG & NG 1 in 8 ½ straight	120
MG & NG 1 in 8 ½ straight	117
MG 1 in 8 ½ curved	169

Heel divergence of 1 in 8 ½ & 1 in 12 (tabel 1.2) curved switches on PSC sleepers is more because the heel is located at longer distance, at a place where the moveable length of tongue rail is flexible enough to be operated with a fixed heel.

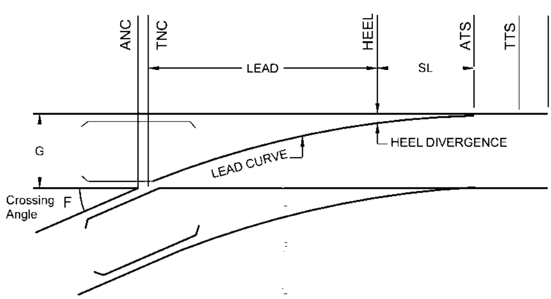


Fig. 1.6 Key dimensions of turnout

1.3 Crossing assembly: It is a device introduced to permit movement of wheel flange at the inter-section of two running rails. For this purpose, it is necessary to provide gap for movement of flange of the wheels to travel across a running rail. Even after the wheel passes for some distance after throat of crossing (fig. 1.7), wheel load is still born by wing rail. Since the wing rail moves outward after throat, the outer portion of wheel tread remains in contact with wing rail. Since the wheel is constrained laterally because of presence of checkrail, a gap is created between wheel flange and wing rail after throat of crossing. In this gap, nose of crossing is introduced. Top surface of crossing is machined lower by 6mm at ANC. This machining starts from a distance 90mm from ANC. Hence, load is transferred on nose only after some distance from ANC i.e. near 90mm. Important components and terms involved in crossing assembly are :-

(a) **Wing rails:** These are the two rails which start from toe of crossing. Wheel moves on wing rails up to ANC and further for some distance after ANC. Thereafter, wheel load is progressively transferred to nose of crossing. (fig. 1.7)

(b) **Throat of crossing:** It is the point at which the converging wing rails of a crossing are closest to each other. (fig. 1.7)

(c) **Toe of crossing:** It is the joint where wing rail of crossing meets the lead rail. Fish plated joint (6 bolts) is provided at this location. The joint should be machined joint to reduce the excessive hammering. (fig. 1.7)

(d) **Heel of crossing:** It is the last fish plated joint (6 bolts) at the end of crossing (fig. 1.7). This joint should also be machined joint to reduce the hammering effect of the wheel. (In case of turnout on concrete sleepers, the track going towards the turnout side is required to be made straight up to the centre of last long sleeper).

(e) **Crossing angle:** It is the angle contained between the gauge lines of the crossing measured at the theoretical nose of crossing.

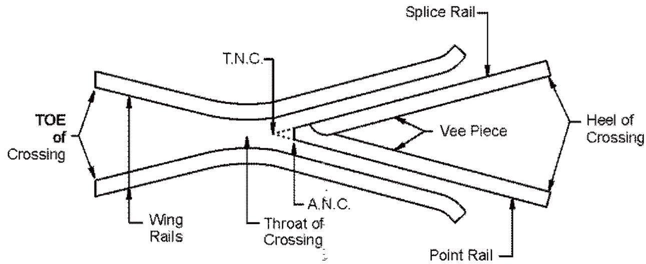


Fig. 1.7 Components of crossing

(f) **Number of crossing:** The number of crossing is the cotangent of angle of crossing. If the angle between legs of crossing is "F", the number of crossing "N" will be equal to "cotF". The number of crossing can be found out in field by measuring the spread between two gauge lines of crossing at an approximate distance of 1m from ANC on both sides. If the spread is approximately 8.5cm, crossing is 1 in 12, if it is approximataly 12cm; it is 1 in 8.5 crossing.

(g) **Point rail:** In case of built up crossing, it is the machined rail, which extends up to the actual nose of crossing (fig. 1.7). Front end of point rail is machined but kept thick enough to take the impact (if any) coming on it. Normally width of point rail is kept equal to the web thickness of the corresponding rail.

(h) **Splice rail:** It is the rail which forms a part of nose of crossing but does not extend up to ANC. It is connected to the point rail with the help of bolts. Point rail and splice rail together form "V" of crossing (fig. 1.7).

In case of CMS crossing, there is no concept of point or splice rail since it is monolithic.

(i) **Theoretical nose of crossing & actual nose of crossing:** Theoretical nose of crossing is the theoretical point of intersection of the gauge lines of a crossing, which is used as a reference point for all layout calculations specially for the turnouts laid on curve (fig. 1.7). The actual nose of crossing is the point at which the spread between the gauge lines of a crossing is sufficient to allow for adequate thickness, from consideration of manufacture and strength. Normally, ANC is provided with a width equal to thickness of web for the corresponding rail section.

1.4 Other important aspects of turnout

a) **Switch Length:** Switch length is the effective length of a tongue rail which moves laterally during setting of the points; or in other words, it is distance from the heel of the switch to the actual toe of switch. Normally, length of switch should be more than the longest wheel base or the maximum distance between any two wheels of the adjacent wagons on safety consideration (fig. 1.6).

b) **Lead of turnout:** It is the track portion between heel of switch to the beginning of crossing assembly. Lead of turnout is measured from the theoretical nose of the crossing to the heel of the switch measured along the straight track (fig. 1.6).

c) **Overall length of turnout:** It is the distance from the stock rail joint to the heel of the crossing measured along the straight track.

(d) **Turn in curve:** Turnouts are always provided to connect 2 tracks, hence on divergent side after heel of crossing (or last long sleeper in case of PSC sleepers) track is laid to connect it to adjoining track. This part of track may be straight or curving in any direction. If it is curved in same direction, it is called connecting curve. However, if this curve is in the direction opposite to the direction of lead curve, it is called turn in curve. (i.e.) track portion between the heel of crossing to the fouling mark (fig. 1.8).

(e) **Machining of tongue rail:** Tongue rails are machined heavily so as to make tip of tongue rail such a thin and low that when pressed against stock rail, wheel can move from stock rail to tongue rail without hitting to the tip of the tongue rail. To ensure it, tongue rail is machined in various stages.

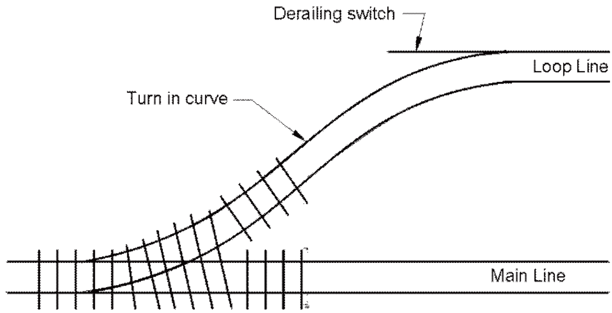


Fig 1.8 Turn in curve

Following are the stages of machining of tongue rails (fig.1.9):

Stage 1- Machining starts from top level of tongue rail at JOH and tongue rail is machined lowered by 22mm at ATS for 1:12 and 1:8.5, 60kg turnout. In case 0f 1:8.5, 52kg turnout this figure is 12mm for PSC sleepers.

Stage 2- Starting from point where tongue rail head width is 13 mm to ATS, it is lowered by another round of machining. Causing the front end be further lowered by 6mm for 1:12 and 1:8.5, 60kg turnout. In case of 1:8.5, 52kg turnout this figure is 13mm.

Stage 3- A corner fillet of radius 12/13mm is made at ATS.

From machining pattern of tongue rail tip (fig. 1.10) it can be understood that a there is a projection of 6mm from gauge face of tongue rail in 1:8.5 turnout, but no projection is there in case of 1:12 turnout on PSC layout. This has got relation with the gauge which is required to be maintained between two stock rails at ATS as per para 237(1)(g) for different design of turnouts.

1.5 Assembly drawings: Assembly drawings numbers of various turnouts being utilized on Indian Railways are given in the (table 1.4)

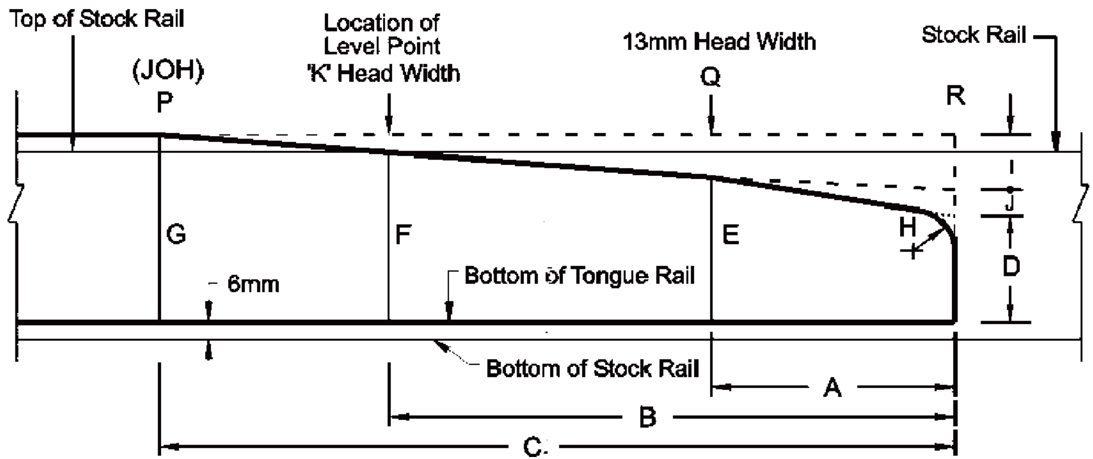
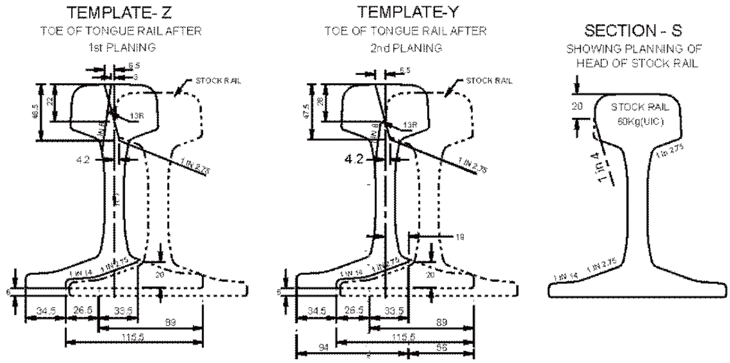


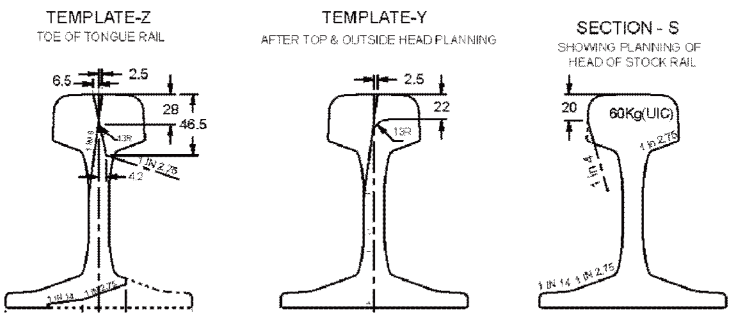
Fig. 1.9 Sketch of tongue rail machining

Table 1.3 Details of machining of tongue rail

	A	B	C	D	E	F	G	H	I	J	Head thickness of tongue rail at level point
1 in 12, 52Kg T-4733/1	1682	4029	5540	128	140.7	150	156	12	22	6	40.34
1 in 12, 60Kg T-4325/1	1682	4244	5840	144	156.4	166	172	12	22	6	43.4
1 in 8.5, 52Kg T-4866/2	476.5	1512	3023	131	145.9	150	156	12	12	13	31.6
1 in 8.5, 60Kg T-4966/1	476.5	2348	3229	144	156.4	166	172	13	22	6	48.25



(a) Machining at ATS for 1 in 8.5, 60 Kg tongue rail



(b) Machining at ATS for 1 in 12, 60 Kg tongue rail

Fig. 1.10 Machining of tongue rail

Important dimensions of the most popular turnout assemblies, which include sleeper spacing, clearances, offsets for turnouts, rail closures etc. are given in following chapters. These dimensions are very important and have to be scrupulously adhered to at the time of assembly of turnout in order to achieve trouble free maintenance during service.

1.6 Turnouts for High Speed: When the speed on straight track is above 250 kmph, High speed turnouts with speed on curved track from 80 to 100 kmph are warranted.

Table 1.4

Rail Sec./ Sleeper	T.O. Drg.. N0.	Switch Drg. No	Xing. Drg. No.
52 Kg/PSC	1:8.5 RT-4865	RT-4866	RT-4867
60 Kg/PSC	1:8.5 RT-4865	RT-4966	RT-4967
60 Kg (Thick Web) / PSC	1:8.5 RT-6279 (Zu-1-60)	RT-6280	RT-4967
52 Kg/PSC	1:12 RT-4732	RT-4733	RT-4734
52Kg/PSC (Thick web)	1:12 RT-5268 (Zu-2-49)	RT-5269	RT-4734
60Kg/PSC	1:12 RT-4218	RT-4219	RT-4220
60Kg/PSC (Thick web)	1:12 RT-6154 (Zu-1-60)	RT-6155	RT-4220
60Kg/PSC	1:16 RT-5691	RT-5692	RT-5693
60Kg/PSC	1: 20 RT-5858	RT-5859	RT-5860
52kg/PSC	1:12, Symmetrical split, RT-5553	RT-5554	RT-4734
60kg/PSC	1:12, Symmetrical split, RT-5553	RT-5554	RT-4220
52kg/PSC	1:8.5, Symmetrical split, RT-5353	TR-5354	RT-4867
60kg/PSC	1:8.5, Symmetrical split, RT-5353	TR-5354	RT-4967

Main factors affecting design of turnout are :-

(i) Kink in the turnout route at the toe of switch rail

(ii) Entry from straight to curve without transition

(iii) Lead curve without super-elevation

(iv) Entry from curve to straight without transition

(v) Gap at the V of crossing

As the wheel negotiates the toe of switch, there is abrupt change in direction resulting in lateral jerk on bogie and corresponding heavy lateral force on tongue rail. The magnitude of force primarily depends on switch entry angle. By reducing the switch angle, entry gets smoothened and flange force gets reduced. The small switch angle is obtained by providing curved/ tangential switches. In tangential type, very small switch angle is possible. Tangential types of switches are used over foreign railways for HSR. As per D72 ORE report and trials over SNCF railway, higher speed can be permitted over T/out by reducing SEA.

Absence of super elevation over Turnout causes unbalanced lateral acceleration and affects safety and comfort. In high speed turnouts, Switch Entry Angles are small and the permissible cant deficiency on the TO curves becomes main criteria for evaluating the permissible speed.

Up-gradation in turnout technology in the railway system has been guided by the following considerations:

(i) Higher speeds on straight and curved tracks with reasonable level of passenger comfort. Designs have been evolved for a speed up to 230 Kmph on turn out track.

(ii) Least life cycle cost with minimum traffic interruption for repairing.

(iii) Track geometry maintainability comparable with the normal track

(iv) Safety and comfort

(v) Planned maintenance without emergencies

The result of the trial made on the SNCF Railway have given very favourable results by :-

(i) Adoption of tangential layouts for higher speeds and Thick web switches.

(ii) Flatter Switch entry angle by tangential layouts thereby reducing the angle of attack and reduced lateral forces resulting in increased passenger comfort.

(iii) Use of spring operated switch setting device to ensure proper flange way clearance.

(iv) Use of movable nose crossings housed in a specially designed cradle, thereby avoiding gap at crossing.

(v) Introduction of transition curves thereby improving the running characteristics of the curved tracks.

(vi) Use of asymmetrical profile section ZU- 1in 60 forged to standard rail profile (UIC 60) at the end.

(vii) Continuation of canting of rails through turnout resulting in smoother ride over turnouts.

(viii) Use of higher UTS steel, further hardened to reduced wear.

(ix) Effective holding of stock rail.

(x) Use of non-greasing eco-friendly base plates.

(xi) Use of specially designed synthetic rail pads for reduced vibration of switch assembly.

(xii) Use of flatter angle of crossing i.e. 1 in 20 or 1in 24.

(xiii) Sophisticated pulling techniques including introduction of hydraulic systems.

(xiv) Surface hardening of load bearing areas.

By these modifications, the forces, accelerations and rolling movements, are found less than the normally allowed limits. Further, the actual sensation felt by the passenger was very good. Based on the these data turnout for HSR can be designed.

■ ■ ■

CHAPTER 2

LAYING OF TURNOUT

2.0 Methods of laying: Before assembling turnout a check list of all the components required must be made available along with their relevant drawings. A check list of various components for most popular turnouts have been provided in annexure 1, 2, 3 and 4.

Methods of laying of turnouts in field are :-

1) In-situ linking: This methodology is adopted only for construction of new line. In case of Open Line, turnouts can be assembled in-situ for remodeling of existing yard only if it is falling in the dead area and it is not causing any infringement to moving dimensions.

2) Pre assembly of complete turnout adjacent to track and replacement as a unit: This method can be used where adequate space is available adjacent to track for assembly of complete turnout and space is available for unhindered movement of T-28 machine.

3) Slewing of preassembled switch and replacements of rest of turnout part by part: This method is normally used when replacement of turnout is to be done by manual means in open line. In this case, preassembled switch is inserted as a complete assembly by side slewing and rest of the sleepers in the lead area are replaced one by one and rails are replaced in small traffic blocks after replacement of sleepers. For replacement of crossing, separate traffic block is taken and all the sleepers and crossing are replaced. In this method switch is assembled close to the location where it is to be laid. This process requires lesser space.

2.1 Selection of method of laying: Selection of method of assembly and insertion of turnout depends on many factors such as:

a) Whether machines like T-28 is available for replacement of turnout.

b) Whether space for assembly of full turnout is available or only switch can be assembled in the available space near the track. Similarly, space for unloading and stacking of sleepers and other assemblies should be located in advance.

c) Whether obstructions like OHE mast, signaling installation, bridges are there to cause obstructions during lateral shifting of turnout during traffic block from place of assembly to place of laying. Heavy shunting operation may also cause obstructions during lateral shifting in case turnout is to be shifted over multiple tracks.

d) Availability of traffic block also affects decision about selection of methodology for laying operation.

Hence, depending upon site conditions and other factors, method of insertion is selected. Following pre-requisites are to be ensured before actual work is taken in hand :-

(i) Adequate space for stacking of turnout components and assembly of turnout.

(ii) Availability of adequate quantity of correct size of bolts, nuts and fittings.

(iii) Proper tools required for assembly and lateral shifting of turnout.

(iv) Standard drawings for different layouts.

(v) Check list of components and their drawing number.

(vi) Trained artisans, trained supervisors and unskilled manpower.

(vii) T-28 machine, if mechanized replacement is planned.

2.2 Checking of Points and Crossings components at the time of assembly: A check list of all the components like switch, crossing, bolts, washers, distance blocks, rubber pads, liners, ERC and sleeper should be made before work of replacement of turnout is taken in hand. Availability of components must be checked with the help of check list. Such list of components for 1:8.5 and 1:12 turnout is available in annexure 1, 2, 3 and 4.

Following important items should be checked:

a) Switch:

i) Whether, the turnout material is of proper design (i.e. 1 in 12 or 1 in 8½, 52 kg/60 kg)?

ii) Whether the layout requires right hand curved or left hand curved switch, since right hand curved switch cannot be inserted at a place where left hand curved switch is required and vice-versa?

iii) All the nuts, bolts as well as spherical washers are available as per list.

b) Crossing:

i) Whether the crossing received is of required design (i.e. 1 in 8½ or 1 in 12, 52 kg/60 kg) and whether this is matching with the switch?

ii) Whether check rails are of suitable design?

iii) Whether all the bolts of required size and spherical washers/taper washers are available?

iv) GFN liners of proper design should be arranged as per section of rail for use in lead and crossing portion.

c) Sleeper set:

i) The sleeper set should be complete. 1 in 12 turnout set consists of 83 sleepers where-as 1 in 8 ½ turnout set consists of 54 sleepers. In addition with every turnout, 1 set of approach sleeper (5 sleepers i.e. 1AS, 2AS, 3A, 4A & 60S) and 2 sets of exit sleeper (i.e. 1E, 2E, 3E and 4E) are also required.

ii) The crossing sleeper should be matching as per design of crossing (i.e. CMS, welded heat treated crossing, moveable nose crossing).

iii) If any sleeper of the set is missing/damaged, same should be arranged before taking work in hand.

2.3 Improvement in the existing layout: Before marking locations of SRJ, ATS, heel of crossing for replacement of turnout or yard remodeling, possibility of improvement in existing layout should be explored. This should be done even in the cases where the job is limited to replacement of turnout without yard remodeling. Existing layout may have many deficiencies such as both or one of the main line not following straight or the designed curved profile. In such conditions existing overall length may or may not suit to the layout requirement. So correction of the geometry should be planned if required, along with turnout replacement. In such cases overall length of cross over may be calculated keeping in view the distance between centre of tracks after proposed alignment correction, and marking of SRJ should be provided accordingly.

2.4 Important issues for assambly and laying of turnout

2.4.1 Precautions during assembly :

1) Spreading of sleeper: Sleeper should be spread as per serial numbers. Serial number is provided on every sleeper of turnout while casting. All the sleepers should be spread according to specified spacing (Fig. 2.22, 2.23 and 2.24). Spacing of sleepers is required to be changed if it is laid on curve; depending on type of curve and flexure, correct table should be selected. This has been explained in detail in chapter 7. The spacing of sleeper for normal overriding switches for straight track as well as curved track has been tabulated in annexure 4, 5 & 6. For thick web switches the spacing of sleeper on switch portion laid on curve of various degree both for similar and contrary flexures is given in annexure A B C. The "RE" mark which indicates the right end of sleeper should be kept always on Right Hand Side irrespective of whether it is right- or left-hand turnout.

2) Cleaning of dowel holes : The holes of dowels provided for fixing of screws may get filled up by earth during handling. These holes should be cleaned by either vacuum cleaner or with the help of pin. While fixing screws to the sleeper, spring washers should always be provided.

3) Checking of pre-curvature of tongue rail or stock rail: Relevant drawings of turnouts specify the required pre-curvature at centre and quarter points of curved tongue rail and curved stock rail. This pre-curvature is provided during manufacturing process; however during loading/unloading/transportation such pre-curvature may get disturbed. If this pre-curvature is lost or changed, it should be corrected with the help of Jim Crow. Care should be taken that no dent marks should be allowed on tongue/ stock rail while correcting pre-curvature with the help of Jim Crow. Recently as per RDSO letter no. CT/PTX/TWS Design dtd 27/ 7/2018 the different versines to stock and tongue rail for laying at different degree of curve has been stipulated. Attempt should be made to achieve the versines as per the referred letter when turnout is taken off from curved main line.

In case of ordinary switches, slight wide gauge at the toe of switch over and above the required widening to house the tip of the tongue rail, may be adjusted by providing suitable steel packing between the web of the stock rail and the lug of the slide chair wherever feasible specially in case of 1 in 8.5 turnout.

4) Correct fixing of switches: The stock rails are fastened to the slide chair with the help of bolts. Every slide chair is fixed to the sleeper with the help of 4 screws. In ideal setting of any tongue rail, back of tongue rail should be flush with the stock rail from ATS to JOH. This may not be fully achieved on turnout because both the tongue rails are tied to each other with the help of stretcher bars at half throw position. After this connection, neutral position of set of both the tongue rails is at half throw. Since a force is applied at ATS by point machine, front portion of tongue rail is pushed towards stock rail to set against stock rail, but the rear portion remains away from stock rail. Because of this fact tongue rail does not set against stock rail at JOH at most of the turnouts. This can be avoided either by point machine installed at JOH or a SSD installed at JOH. In the absence of any force at JOH gap cannot be made zero at this location. Improper setting could be because of one or more of the following reasons:

a) Pre-curvature of tongue rail not provided properly.

b) While fixing stretcher bar, back to back distance between the webs of tongue rails have not been maintained as per design. Stretcher bars should be of standard length. In case it is longer, opening between back of open tongue rail and stock rail at JOH will be lesser. In case it is of shorter length, it may lead to non bearing of closed tongue rail against stock rail for few sleepers.

c) Inadequate throw of switch: for new turnout minimum throw of switch should be 115±3mm, for thick web switch it is increased to 160mm.

d) Non fixing of stretcher bar at half throw.

It is found that if the opening between tongue and stock rail at JOH is limited to 10/12 mm without any force at JOH, after application of force by crow bar at JOH, the gap could be fully closed. In such cases if spring setting device is provided (with opening at JOH without SSD limited to 10/12mm), it will fully set the tongue rail at JOH. To ensure proper setting of tongue rail from ATS to JOH, multiple point machines are provided in the modern turnouts worldwide.

5) Fixing of stretcher bar:

(a) Stretcher bar is fixed to the tongue rail at the time when both the tongue rails are at half throw (i.e. 57.5mm for 115mm throw or 80mm for 160mm throw). Gauge between stock rails at ATS should be made exactly as per requirement.

(b) 2 Holes of 18mm are drilled by manufacturer in stretcher bar for fixing bracket to one of the tongue rails with the help of turned bolts, but the other 2 holes are required to be drilled in situ to fix other tongue rail in such a way that back to back distance of the web/web stiffener of tongue rails is maintained as per relevant drawing. Stretcher bars are connected to the bracket with 18mm turned bolts. Back to back distances between webs of tongue rails are given in the table (Table-2.1)

For other turnouts, required distances may be checked up from the concerned drawing.

(c) There should be a clearance of 1.5mm to 5mm between the bottom of Stock Rail and top of stretcher bar.

Table 2.1

TURNOUT	**1:12**		**1:8.5**		**1:16**
	60 kg	**52 kg**	**60 kg**	**52 kg**	**60 kg**
LEADING	1530	1530.5	1558	1559	1526
Ist Following	1544	1545	1577.5	1578	1543
IInd Following	1566	1566	1596.5	1596.5	1546
IIIrd Following	1576	1579	-----	-----	1593

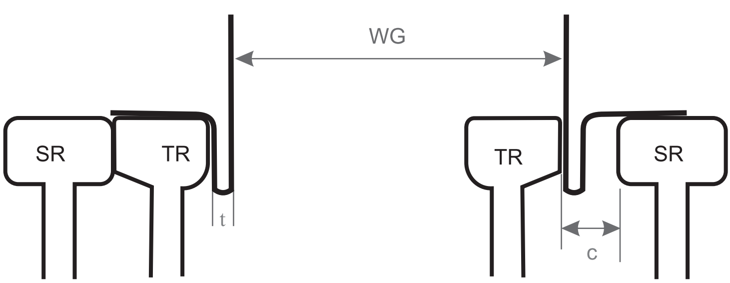
(d) Stretcher bar should not be bent.

(e) All the stretcher bar bolts must be provided.

(f) If the turnout is in track circuited territory, stretcher bar should be insulated.

6) Throw of switch: Minimum throw of switch for BG for new work should be 115±3mm. If proper stretcher bars are used, such a throw is possible from track structure point of view. The actual amount of throw is provided by point machine. Point machines are designed with maximum stroke of 143mm, to enable throw of 115mm. If less throw of switch is provided, it may pose troubles such as improper bearing of tongue rail against stock rail on one side. On opposite side clearance between the back face of open tongue rail and stock rail gauge face will be inadequate for passage of wheel, hence the wheel may rub against non gauge face of tongue rail which may set tongue rail and the stretcher bars in oscillatory motion. Hence, achieving proper throw of switch is important. For existing work, minimum throw of switch is 95mm.

7) Gap at JOH when tongue Rail is in open condition: if setting of tongue rail is proper and setting up to JOH i.e. the gap between SR and TR at JOH on closed side is zero, the gap at JOH on opposite side when measured should be 56.5 mm or more as explained in following sketch-

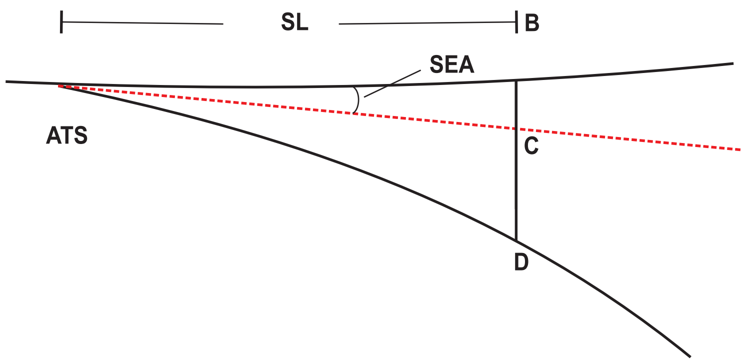


WG + t +c > 1673 where, 't' is thickness of worn flange

WG is wheel gauge =1600 mm

hence 'c' should be more than 1673-1600-16.5=56.5 mm

8) Heel Divergence: Heel divergence is a design parameter and has been decided based on the curvature of turnout and the switch entery angle. It does not depend on the section of the rail i.e. heel divergence for both 60 Kg 1 in 12 or 52 Kg 1 in 12 turnout is same. The heel divergence is worked out as deliberated under-



Heel divergence = BD = BC + CD

BC = SL * Tan (SEA), CD = SL*SL/2R, hence,

Heel divergence = SL*Tan(SEA)+SL*SL/2R

Where, SL is switch length, SEA is switch entry angle, R is radius of turn out. If tongue rail is projecting from gauge face of SR as in case of 1 in 8.5 then thickness of TR at toe will also be added.

9) Provision of proper stud bolts: There are two types of stud bolts used in switch assembly for fixing the stock rail with the slide chairs; one with the thinner head known as 'half headed' stud bolt and other with normal size of head called stud bolt. It is essential to ensure that for the initial few sleepers only half headed stud bolts are used, so as not to present any obstruction between web of stock rail and tongue rail while butting against each other. In case of breakage of such bolts, it should be replaced by half headed bolts only.

10) Use of slide chair with defective lugs: The stock rail is fastened to the lugs of slide chair with the help of stud bolts. The horizontal piece of lug is connected to the slide chair with the help of welding. Sometimes this welding may get cracked because of carelessness during handling. This should be checked and if required welding may be resorted to. In case of new design rivet is also provided to hold the plates together.

11) Use of proper distance block and special bearing plate: After heel of switch at many places tongue and stock rail are tied together with the help of distance blocks Maintenance of gauge and alignment in this part depends on use of proper distance block. So all such blocks should be checked as per drawing and the actual offset of tongue rail should also be checked to ensure proper fixing.

12) Use of proper switch stops and slide blocks: Switch stops are bolted to tongue rail whereas slide blocks are bolted to stock rail. Switch stops and slide blocks are provided to transfer lateral force exerted by wheel on the tongue rails to stock rails. Switch Stops or slide blocks of proper design are required to be provided as per drawing. In 1 in 8 ½ turnouts switch stops are provided, whereas in 1 in 12, 1 in 16 and 1 in 20, slide blocks are provided.

13) Welding of SRJ: It is one of the recommended practices to weld SRJ to the extent possible. If it is not possible to weld SRJ, it should be made as machined joint.

14) Machined/gapless joint: The hammering effect of wheel on fish plated joint increases with increase of gap. So to the extent possible fish plated joints are avoided on point and crossing. In case fish plated joints are unavoidable, its ill effects can be minimized by making it gapless for reduced hammering action. Joints in turnouts are to be either made machined/gapless or welded as per drawing. To make gapless/machined joint, drill bit of 26.5mm diameter should be used. The holes in switches and crossings received from trade are drilled by 26.5mm by the manufacturer. The distance of hole to be drilled in the rail should be 83mm from the nearest rail end. However, as an additional precaution, the distance between rail end and the holes in crossing/switch drilled by manufacturer should also be measured. If it is found that the distance is less than 83mm, deficiency should be added to the distance of 83mm to be measured for the drilling of holes in the rail to be connected. It may be noted that this arrangement will provide gapless joint only at temperature equal or more than installation temperature. Some play would still be available between bolt/rail and bolt/fishplate which may cause some gap. This arrangement provides a maximum theoretically possible gap of 3.5mm at temperature lower than installation temperature. Provision of proper gapless joint may reduce the cases of cracking of CMS crossing near toe and heel of crossing.

All the fish plates in concrete sleeper track should be with 6 bolts.

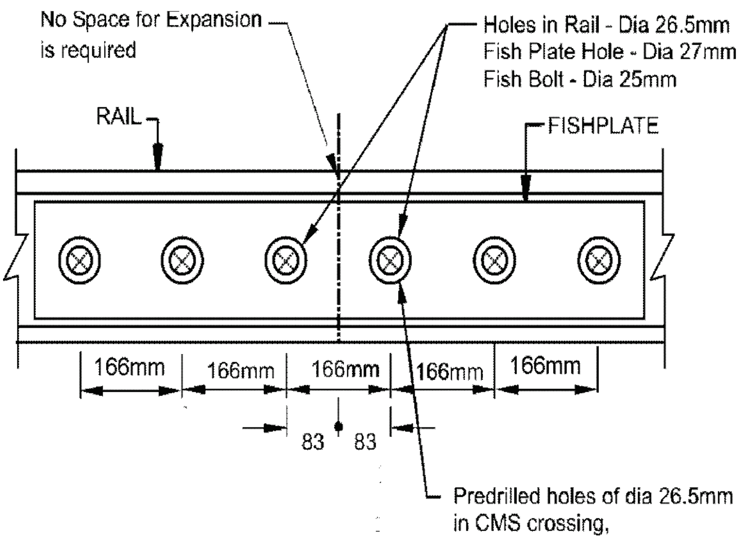


Fig. 2.1 Machined Joint

15) Gauge tie plate: On turnout with concrete sleepers, only one gauge tie plate is used i.e. under ATS at sleeper number 3. Although gauge holding by sleeper has improved a lot because of concrete sleepers, however as an additional precaution gauge tie plate is used under ATS to take care of heavy thrust coming there. This should be of insulated type.

16) Spherical washers: Spherical washers are required to be provided for the bolt joining 2 planes which are not parallel to each other. At many locations on turnout, such as heel of switch, distance blocks behind heel and in the crossing portion, non parallel planes (rails) are connected with each other with the help of bolts with spherical washer. At such locations, holes are drilled perpendicular to one of the rail and on the other rail, where direction of bolt is not perpendicular to the rail, spherical washers are provided (fig. 2.2). In case, spherical washer is not provided while joining two non parallel surfaces, one edge of bolt will press against the web of rail causing bending/breakage of bolt (fig.2.3). In order to make provision of spherical washer simpler, following rules have been formed:

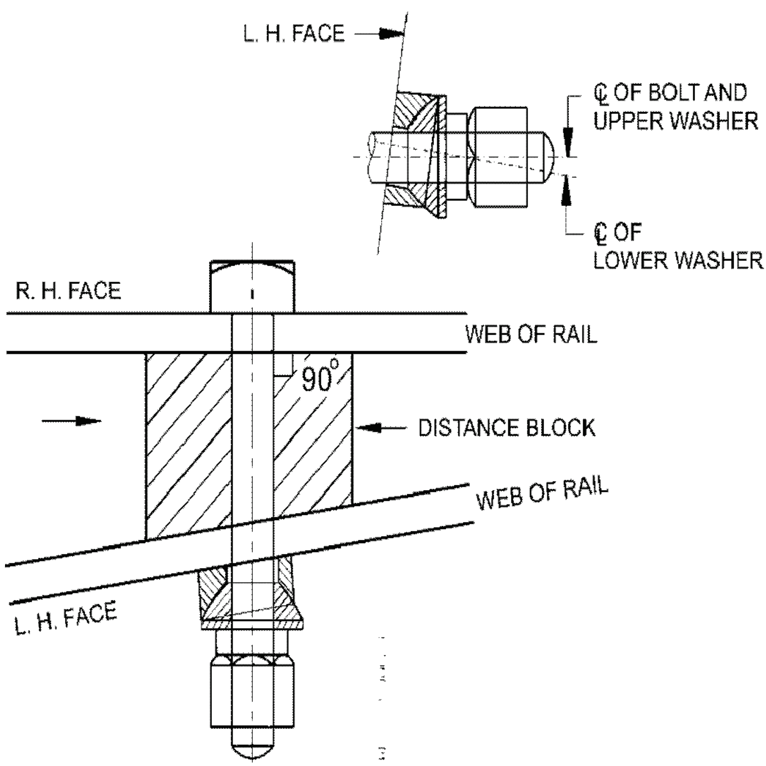


Fig. 2.2 Spherical Washer

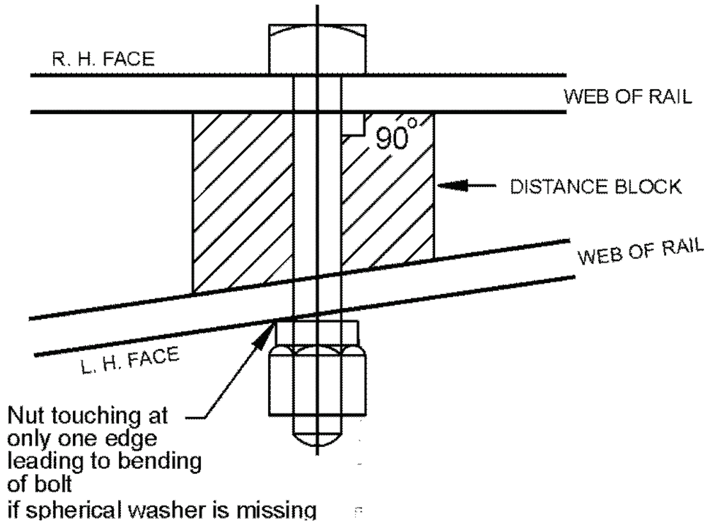


Fig. 2.3 Effect of non-provision of Spherical Washers

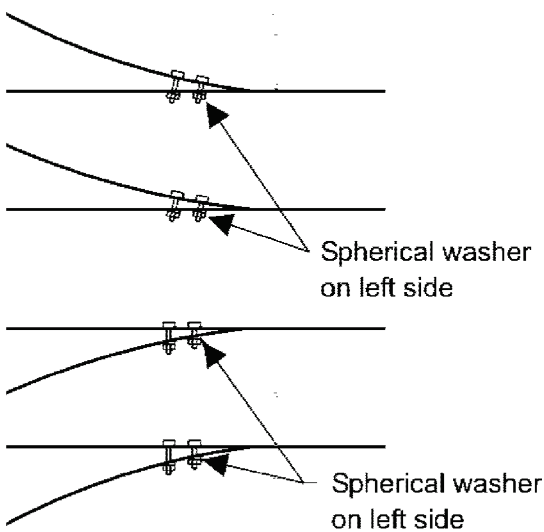


Fig. 2.4 Spherical washers at heel of switch

a) At the heel of switch and the distance blocks behind heel, spherical washers are to be provided on the left hand side irrespective of whether it is a left hand turnout or right hand turnout. At these locations, holes are drilled perpendicular to the rail which is on right hand side so that spherical washers are required on other side (fig. 2.4).

b) In the crossing portion, spherical washers are required to be provided on both sides, as the holes are drilled perpendicular to the bisector of crossing legs and the axis of bolt is not perpendicular to any of the plane. At crossing, spherical washers can be replaced with taper washers. These taper washers are specifically designed for 1 in 12 or 1 in 8.5 turnouts.

In case of breakage of bolts, spherical washers also fall. Keymen, if not properly trained, may fix washers on either wrong side or fix it wrongly. In such cases, only one side of head of bolt will come in contact with rail leading to eccentric forces (fig. 2.3). This will set a bending moment in the bolt. This bolt is likely to bend and break with in few days again. Hence training of keymen about proper fixing of spherical washers is very important.

17) Special approach and exit sleepers: Rails on a normal track are laid with a cant of 1 in 20 whereas on turnouts these are laid without any cant. Hence, it is necessary to provide a mechanism through which cant is gradually reduced to zero. In order to provide such reverse canting, one set of 4 special sleepers is provided near the SRJ and 2 such sets are provided on either side after the heel of crossing. On the approach of turnout, sleepers numbered as 1AS, 2AS, 3A and 4A are used. Near the crossing, a set of 4 sleepers i.e. 1E, 2E, 3E and 4E are used. The rail seat under 1AS/1E is made horizontal; on 2AS/2E it is provided with slope of 1:80, on 3A/3E slope is 1:40 and on 4A/4E slope of 1:26.5 is provided. Care should be taken that 1AS or 1E should be towards turnout side and 4A or 4E should be away from turnout. Such arrangement is required to be provided on all the turnouts except at the location where immediately after one turnout other turnout starts without any space for such sleepers specially in goods yard. If the space between 2 turnouts is inadequate for all the 4 sleepers, equal number of exit/approach sleepers should be provided from both the sides.

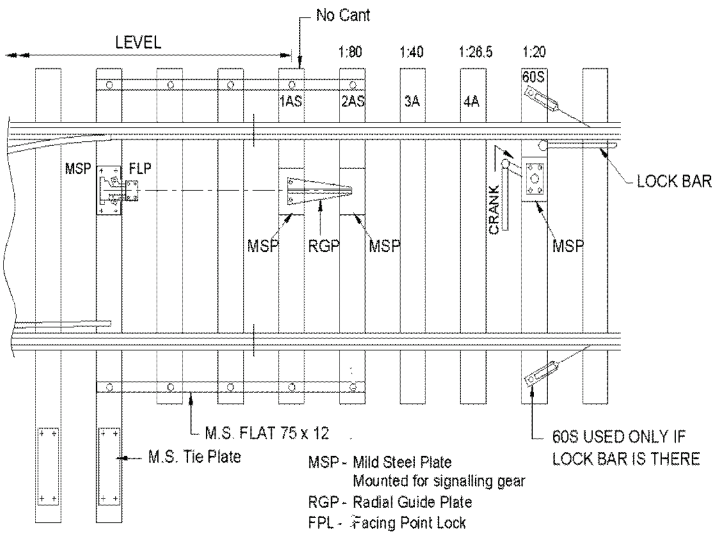


Fig. 2.5 General arrangement on approach of switch

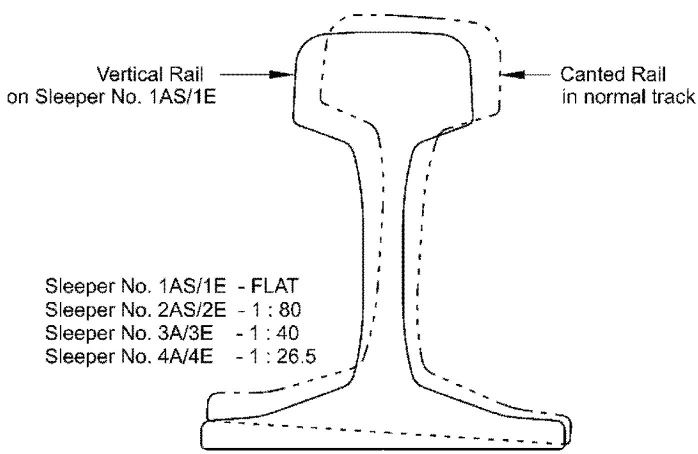


Fig. 2.6 Running out of cant before turnout

18) Provision of proper liners: All the concrete sleepers are designed for 60 kg rails. So while using 60 kg rail, GFN liners RDSO/T-3706 are only used everywhere with ERC. In case 52kg rails (switch, lead and crossing) are used, on the crossing GFN liners RDSO/T-3702 should be used, on the check rail (both sides i.e. check rail and running rail) GFN liners RDSO/T-3708 should be used, in the lead portion (except sleepers with special bearing plates) combination liner RDSO/T-3707 and RDSO/T-3708 should be used on inside and outside respectively. On the sleepers just after heel of switch i.e. sleeper no. 14, 15, 16 in 1 in 8 ½ and sleeper number 21 to 27 on 1 in 12, GFN liners RDSO/T-3702 is to be used when 52 kg rail is used.

Table : 2.2

Location	Turnout with 60 kg rail		Turnout with 52 kg rail	
	Inside	Out side	Inside	Out side
Crossing	3706	3706	3702	3702
Check rail	3706	3706	3708	3708
Special bearing plate sleeper no 21-27(1:12) or 15-17(1:8.5)	3706	3706	3702	3702
Rest of lead curve	3706	3706	3707	3708

19) Gauge at nose of crossing: The gauge at nose of crossing as well as other places on the crossing is very important. In case where crossing is not exactly at centre, slack or tight gauge on one of the track will lead to tight or slack gauge on the other track. Tight gauge may lead to the possibility of wheel flange hitting the nose of crossing; hence gauge to a better accuracy should be maintained on crossing. Too slack gauge at ANC is likely to cause more wear to check rails. Limits as per IRPWM are 0 to +4mm

20) Check rail clearance: Check rail provides lateral guidance to the wheel in the unguided gap between throat of crossing to ANC in the crossing area.

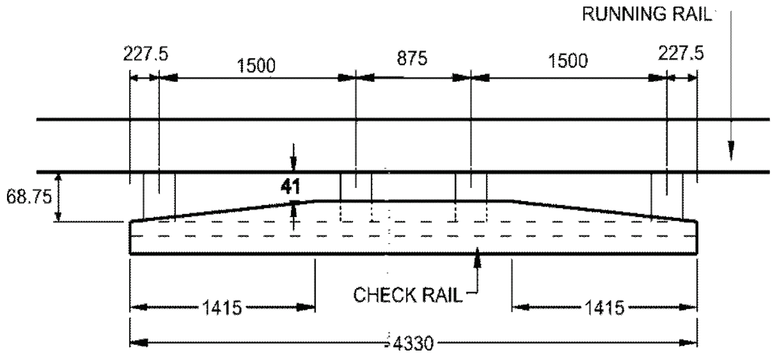


Fig. 2.7 Check Rail for turnout on PSC sleepers.

For the PSC track (for which the gauge to be maintained at 1673mm), check rail clearance to be maintained between 41 to 45mm. With the new fittings initial gap should normally be 41mm, provided all the bolts are tightened properly. The distance blocks between running rail and check rail is made of three different pieces. One of the 3 blocks is bigger; other two have thickness of 3.15mm each. The gap of checkrail may increase because of wear of check rail by rubbing against back of wheel flange. When it crosses the threshold limit one of the pieces of 3.15mm is removed to reduce the gap. In case of further wear, other piece is also removed. In case the gap further reaches 45mm, now this check rail will have to be replaced by new/reconditioned checkrail. Opening of flared end is initially 68.75mm, this opening has been designed wide enough to trap any wheel without allowing any possibility for it to hit tip of check rail.

21) Provision of spring washers: Because of heavy vibrations being transmitted during passage of traffic, various plate screws and bolts provided in turnout are likely to get loosened. So it is desirable to provide spring washers at all such locations to avoid loosening of screws and bolts. Vibrations are particularly heavy in crossing zone. In the switch area spring washers should be used with stud bolts and plate screws.

2.4.2 Radius of turn in curve :

a) Passenger running loops: Turn-in curve is a curve provided after heel of crossing on the turnout side which meets with the loop line or adjoining track. In case of turnout on concrete sleepers, turn in curve starts after centre of last long/common sleeper. Normally radius of turn-in curve is quite sharper. At the time of yard design, radius of turn-in curve should be selected in such a way that it suits to the geometry and speed potential of loop. Para 410(2) of IRPWM provides certain stipulations for selection of radius of turn in curve which reads as under:

Radius of turn in curve should be generally be not less than 350 meter however, where it is not practical to achieve the radius of curvature of turn in curves as 350m on account of existing track centers for the turn out taking off from curves, the turn in curve may be allowed upto a minimum radius of 220 metre subjected to following:

(i) Such turn in curves should be provided either on PSC or steel trough sleepers only, with sleeper spacing same as for the main line.

(ii) Full ballast profile should be provided as for track for main line.

As this clause being very important, at the time of yard design we must attempt to provide radius of turn in curve equal to 441m (i.e. radius of lead curve of 1 in 12 turnout). This will ensure that in future if required speed on loop can be raised to speed potential of turnout. However if there is shortage of space **in the yard, in case of straight main line** turn in curve radius can be reduced to 350m. Other important provisions as given in para 408 to 414 should be also be observed while laying of turnout in field.

b) Other loops: In case of other than passenger running loops, the radius of lead curve is guided by provision of Schedule of Dimension, clause 17, chapter 2. Minimum radius should not be less than 218m.

2.4.3 Rechecking of layout before replacement of turnout: While laying/replacing turnout, possibility of improvement to the track geometry should be explored. In case there is some false curve near turnout, attempts should be made to remove such unwanted curves or other irregularities. Even if no improvement is expected, layout calculations must be made again to ensure proper layout after replacement. In case, the overall length is not provided close to theoretical overall length, it will lead to kinky alignment either on the main line side or on the cross over side. Layout calculation software in this regard is available on IRICEN website free of cost, can be downloaded and user friendly and covers most of the cases which is usually encountered in the field. However, a table containing standard distances for simple layout has been made which can be directly by field staff as below.

Table 2.3

Cross over 1 in 12, 60kg/52kg on PSC sleepers laid on straight for normal spacing (Fig. 2.8)

Track centre in mm T/C less than 4755mm not possible	Overall length in mm If required to be laid at track centre less than 4755mm, few long sleepers at the end not to be inserted.
4755	91038
4800	91578
4900	92778
5000	93978

Note : 1. T/C less than 4755mm not possible.If required to be laid at track centre less than 4755mm, few long sleepers at the end not to be inserted.

2.The overall length have been provided upto 5.0 m track centre. Thereafter for every 100mm increase in track centre, increase overall length by 1200 mm.

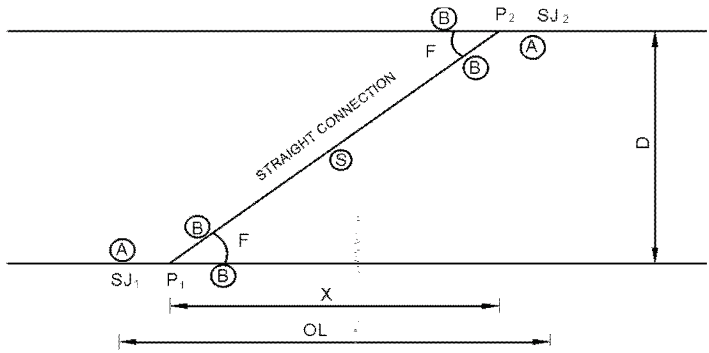


Fig. 2.8 Cross over 1:12/1:8.5 on straight track

Table 2.4

Cross over 1 in 8.5, 52kg/60kg on PSC sleeper laid on straight for normal spacing (Fig. 2.8)

Track centre in mm	Overall length in mm
T/C less than 4625mm not possible	If required to be laid at track centre less than 4625mm, few long sleepers at the end not to be inserted.
4625	63363
4700	64000
4800	64850
4900	65700
T/C less than 4625mm not possible	

Note : *1. T/C less than 4625mm not possible. If required to be laid at track centre less than 4625mm, few long sleepers at the end not to be inserted.*

2.The overall length have been provided upto 5.0 m track centre. Thereafter for every 100mm increase in track centre, increase overall length by 850 mm.

Table 2.5

Cross over between curved parallel track, 1 in 12, 60kg/ 52kg on PSC sleeper (Fig. 2.9)

Degree of main main line curve	**Track Centre in mm**	4770	4800	4900	5000	5100	5200	5300
Curve 1^0 or R=1750m	Overall length along rail of inner track in mm	91200	91556	92753	93951	95150	96348	97546
	Connecting curve radius in metres	11296	2635	1976	1882	1846	1825	1813
Curve 2^0 or R=875m	Overall length along rail of inner track in mm	91170	91531	92728	93924	95121	96318	97514
	Connecting curve radius in metres	5654	1319	989	943	924	914	908
Curve 3^0 or or R = 583.3m	Overall length along rail of inner track in mm	91147	91507	92702	93897	95092	96288	97481
	Connecting curve radius in metres	3770	880	660	629	617	610	606

Note: *In this case overall length is measured along outer rail of inner track. It can be seen that the overall length of cross over does not change with increase in main line curve degree. It can also be seen that overall length on curved parallel track is almost equal to that of straight parallel tracks as given in Table 2.1.*

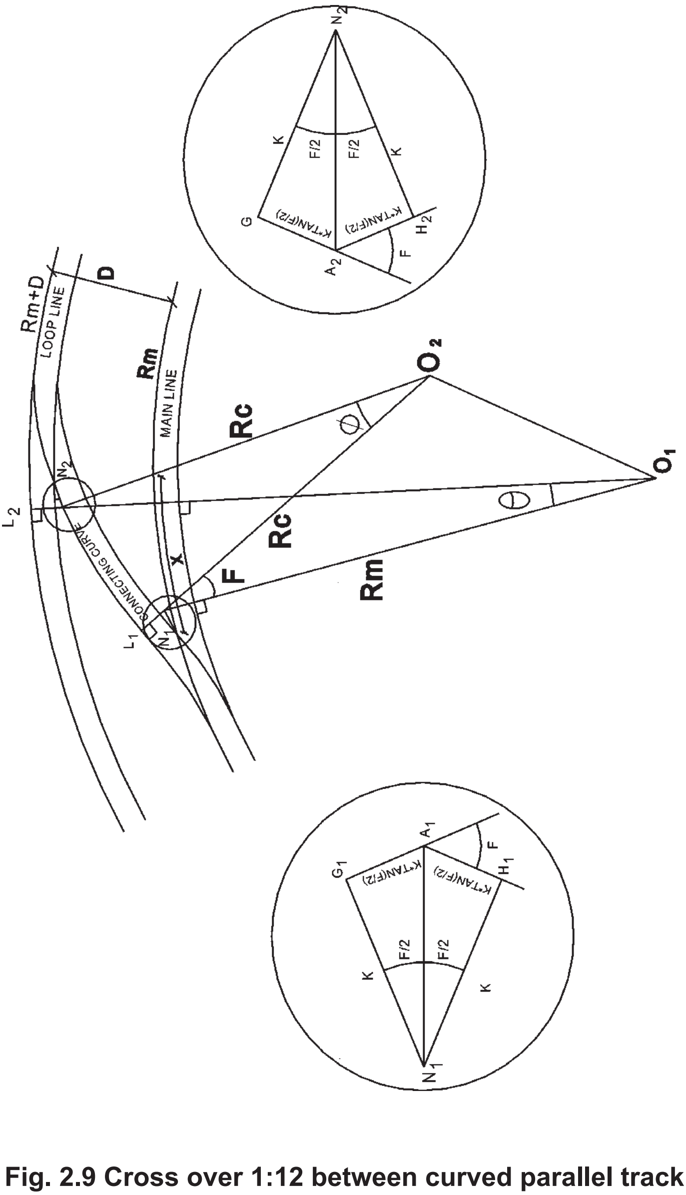


Fig. 2.9 Cross over 1:12 between curved parallel track

Table 2.6

Cross over (60/52/90R) 1:8.5 sand hump point to 1:12 turnout on Main Line (fig. 2.10)

Track centre in mm	Radius of connecting curve in mm	Overall length in mm
4250	441000	87476
4300	441000	88076
4400	441000	89276
4500	441000	90476
4725	441000	93176
4900	441000	95276
5100	441000	97676
5300	441000	100076

Note: Thereafter for every 100mm increase in track centre, increase overall length by 1200 mm.

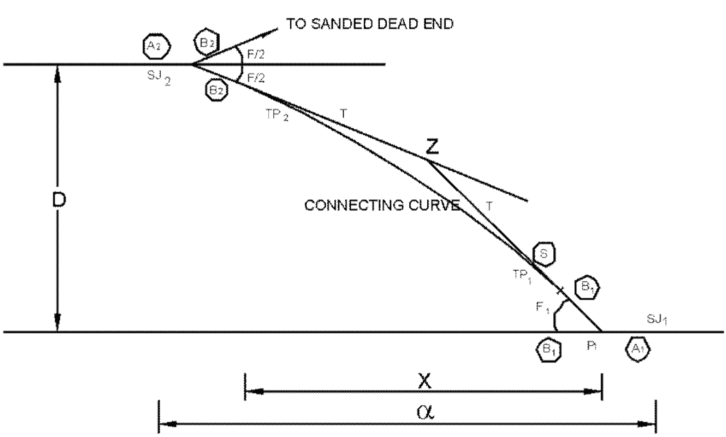


Fig. 2.10 Cross over 1:8.5 symmetrical split on loopline to 1:12 on main line

Table 2.7

Connection from 1:12 turnout laid on straight main line to parallel loop line (fig. 2.11)

Radius of connecting curve in metres	Track centre in mm	OL length in mm	Length of straight after last long sleeper in mm (s)
350	4265	82727	8197
	4300	83147	8619
	4400	84347	9823
	4500	85547	11027
300	4265	80647	10277
	4300	81067	10698
	4400	82267	11903
	4500	83467	13167
250	4265	78568	12357
	4300	78988	12778
	4400	80188	13982
	4500	81388	15187
220	4265	77320	13605
	4300	77740	14026
	4400	78940	15230
	4500	80140	16434

Note: This table is only used for normal spacing of track.

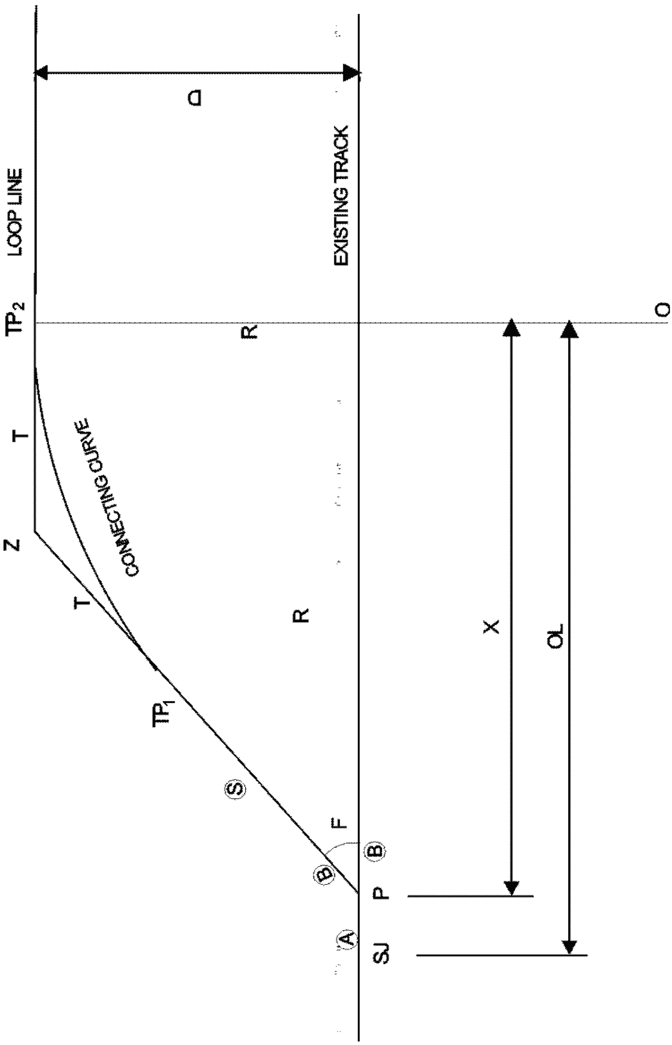


Fig. 2.11 Connection, 1:12 turnout laid on straight main line to parallel loop line

Table 2.8

Connection from 1:12 turnout on curved main line to loop line on out side (Fig. 2.12)

Radius of connecting curve in metres	Track centre in mm	OL length in mm	Length of straight after last long sleeper in mm (s)
1750	4265	90.886	418.344
	4500	96.527	456.789
	4725	101.930	491.606
	4900	106.129	517.411
	5100	110.928	545.644
	5300	115.728	572.645
1167	4265	90.869	374.281
	4500	96.505	404.724
	4725	101.899	431.778
	4900	106.094	451.541
	5100	110.887	472.879
	5300	115.678	492.995
875	4265	90.848	338.606
	4500	96.478	363.310
	4725	101.866	384.945
	4900	106.056	400.565
	5100	110.841	417.258
	5300	115.625	432.834
700	4265	90.825	309.214
	4500	96.449	329.670
	4725	101.831	347.375
	4900	106.014	360.038
	5100	110.793	373.461
	5300	115.568	385.886

Note : In this case overall leagth is measured along outer rail of inside track. From the above table it can be concluded that the overall length of connection does not change much when the degree of mainline curve changes. It only increases with increase in track centres. However with decrease in radius of main line curve radius of turn in curve also decreases.

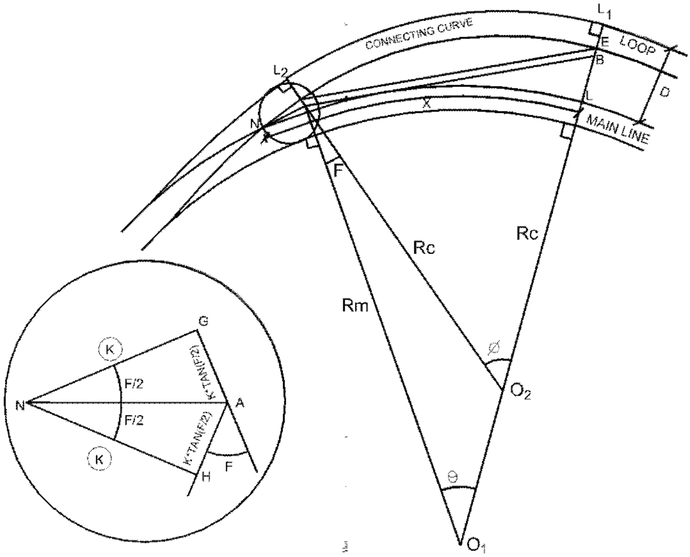


Fig. 2.12 Connection, 1:12 turnout on curved main line to loop line on outside

Table 2.9

Connection from 1:12 turnout on curved main line to loop line on inside (Fig. 2.13)

Radius of main line curve in metres	Track centre in mm	OL length in mm	Radius of connecting curve after last long sleeper in m (s)
1750	4265	90956	-794
	4500	96612	-946

	4725	102028	-1110
	4900	106241	-1252
	5100	111056	-1433
	5300	115871	-1637
1167	4265	90970	-1026
	4500	96628	-1297
	4725	102047	-1626
	4900	106262	-1951
	5100	111079	-2429
	5300	115896	-3080
875	4265	90982	-1456
	4500	96643	-2067
	4725	102063	-3053
	4900	106279	-4440
	5100	111097	-8043
	5300	115916	-26844
700	4265	90993	-2502
	4500	96655	-5091
	4725	102077	-25019
	4900	106293	16013
	5100	111112	6120
	5300	115931	3991
500	4265	91012	5662
	4500	96675	2631
	4725	102097	1863
	4900	106313	1564
5100	111131	1350	
5300	115947	1208	

Note : Negative values indicate a reverse curve.

Note: 1) *In this case overall leagth is measured along inside rail of outer track.*

2) *From the above table it can be concluded that the overall length of connection does not change when the degree of mainline changes. It only increases with increase in track centres.*

3) *In case of mild curve on main line, the turn in curve is having negative radius.* ***That means that immediately after heel of*** *crossing there will be a reverse curve making its maintenance very difficult. Special precautions should be taken while running down cross level on such reverse curve (refer para 414 (2) of IRPWM). With the decrease in radius of main line curve, radius of such reverse curve increases and it becomes flatter. At mainline radius of approximately 548m with track centre of 5300mm it becomes almost straight and with further reduction in main line radius, connecting curve radius becomes positive. Such connecting curve should be maintained as per para 414 (1) of IRPWM.*

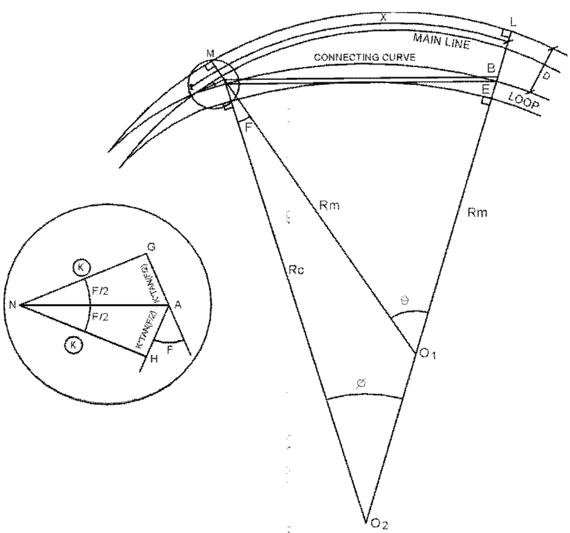


Fig. 2.13 Connection, 1:12 turnout on curved main line to loop line on inside

2.4.4 Spring setting devices: For the best performance, tongue rail should bear against the stock rail from ATS to JOH. However, achieving setting of tongue rail up to JOH may be difficult in the field. Since the stretcher bar is fixed to the tongue rail while the tongue rails are at half throw; it sets a force in tongue rail, when it is pressed against any stock rail. Point machine presses the tongue rail against one of the stock rail at the ATS but in the absence of any force near JOH, tongue rail opens out at this location.

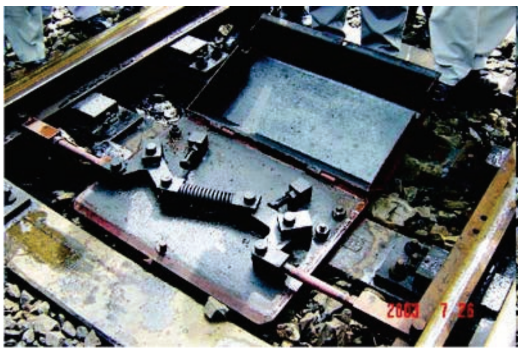


Fig. 2.14 Spring setting device

In most of the European Railways, point machine is provided at two or more locations on the tongue rail including one at the ATS and another at JOH, which ensures proper setting of tongue rail. Since on Indian Railways signalling department is not providing point machine at JOH, spring setting device has been developed which provides thrust on the tongue rail, near JOH so that the tongue rail bears well against the stock rail. As per present orders, only RDSO approved design of SSD are to be used.

Spring setting device is provided with springs which initially opposes the movement of tongue rail at the time of beginning of change of direction till the time tongue rail crosses half throw. After passing a particular position, direction of force provided by spring changes and it provides a force to press the tongue rail which is to be set for train movement. Thus it presses tongue rail against the stock rail at JOH. This is to be fixed on sleeper No. 13

for 1 in 12, 52kg switch and on sleeper no. 12 for 1 in 12,60kg switch and on sleeper no. 8 in 1 in 8 ½ turnout for 52/60kg switch. Provision of spring setting device may take care of problems such as tongue rail not fully bearing against stock rail up to JOH. It will also take care of inadequate clearance of open tongue rail and stock rail at JOH, which is particularly more pronounced in case of 1 in 12 turnouts.

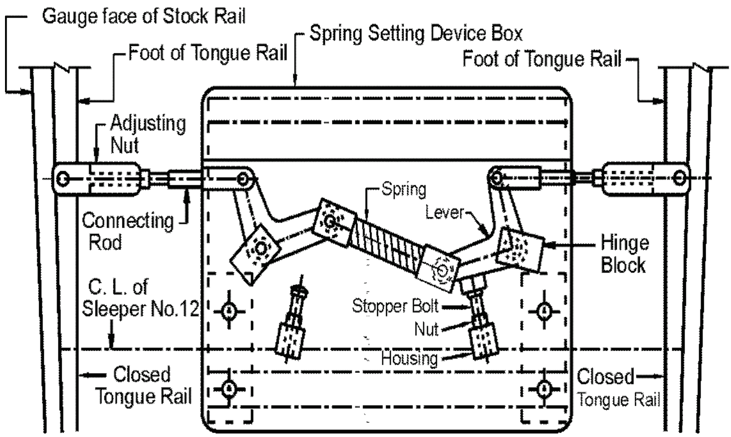


Fig. 2.15 Spring setting device

Same problem is also seen in 1 in 8.5 turnout laid on curve. Spring setting device is able to provide opening of tongue rail of 60 ± 2mm at JOH. It also takes care of rattling of tongue rail under passage of wheels. Because of all these reasons wear of tongue rail can also be reduced to some extent.

It is desirable that all turnouts on main line are provided with SSD, however on the pretext of certain problems S&T department is opposing installation of SSD. It is also found that in case of thick web switches where provision of SSD is mandatory, it is working very satisfactorily. In Mumbai suburban area, the gap between stock and tongue rail at JOH could be reduced to zero because of SSD.

At many places it has been seen that even after providing SSD, tongue rail is not fully set at JOH. The force which can be created by SSD has certain limitations, if the tongue rail has not been pre-curved as per requirement, it may lead to this situation. Hence attempt should be made that the tongue rails are given proper pre-curvature before laying, then only perfect setting can be obtained with the help of SSD. It is also felt in field that if before fixing of SSD, opening at JOH is limited to 10/12 mm, after fixing SSD, zero gap at SSD can be obtained. Hence opening should be reduced to these limits by correcting pre curvature of tongue rail before SSD is installed. Otherwise, even after fixing of SSD, gap at JOH may not be fully eliminated.

2.4.5 Replacement of 1 in 8.5 ladder on wooden sleeper laid at limiting angle by turnout with PSC sleeper and CMS crossing: In most of the goods yards, 1 in 8.5 ladder have been laid at limiting angle i.e. laid in such a way that SRJ of next turnout is exactly at the place of heel of crossing of earlier turnout. All such old ladders have been laid on wooden sleeper/steel trough with ordinary built up crossing. Since length of CMS crossings after TNC i.e. from TNC to heel of crossing is lesser than that of built up crossing, while replacing wooden/steel layout by concrete sleeper with CMS crossing, the old arrangement does not work satisfactorily and a small rail piece of approximate length 907mm is required to be provided. In case of replacement of wooden sleeper on ladder by PSC sleeper 2 sets of problems crop up:

1) Problems in laying sleepers between HOC and SRJ
2) Problems because of involved small rail pieces

Because of presence of fish plated joint area near heel of crossing is always a weak area. The presence of small rail piece may further make track weaker in this area. So to improve the sturdiness of layout at this location attempt should be made to provide more number of longer sleepers even at the cost of avoiding sleeper no. 1 and 2 of next turnout. How ever holes may be required to be drilled in long sleepers to provide angle longitudinally to group the sleepers near ATS.

No fixed guidelines are available to deal with problems described above. However, four different solutions which could be thought of, have been given below. One can select the best suited solution for the layout. In normal circumstances amongst the solutions given below (d) seems to be most suitable in the field.

a) By keeping the same limiting angle but by shifting SRJ of all the turnouts on ladder to heel of crossing (Fig 2.16)

In case of ladder with PSC sleepers, sharper limiting angle of ladder is possible than that of ladder with wooden sleeper. Hence if ladder is kept at the same angle (to avoid major remodeling of yard) SRJ of turnouts on PSC sleeper will not come exactly at heel of crossing. We need to introduce a rail piece of 907mm between SRJ and heel of crossing. In such circumstances to avoid such a small rail piece, SRJ can be moved to such extent that it touches the heel of CMS crossing. However, while doing so, the location of the end of turn in curve on every loop will move slightly inside loop line. Since the SRJ of first turnout moves by 907mm, SRJ of next turnout will move 907X2=1814mm and so on. The best possible arrangement of sleepers between heel of crossing and SRJ can be seen in fig 2.17.

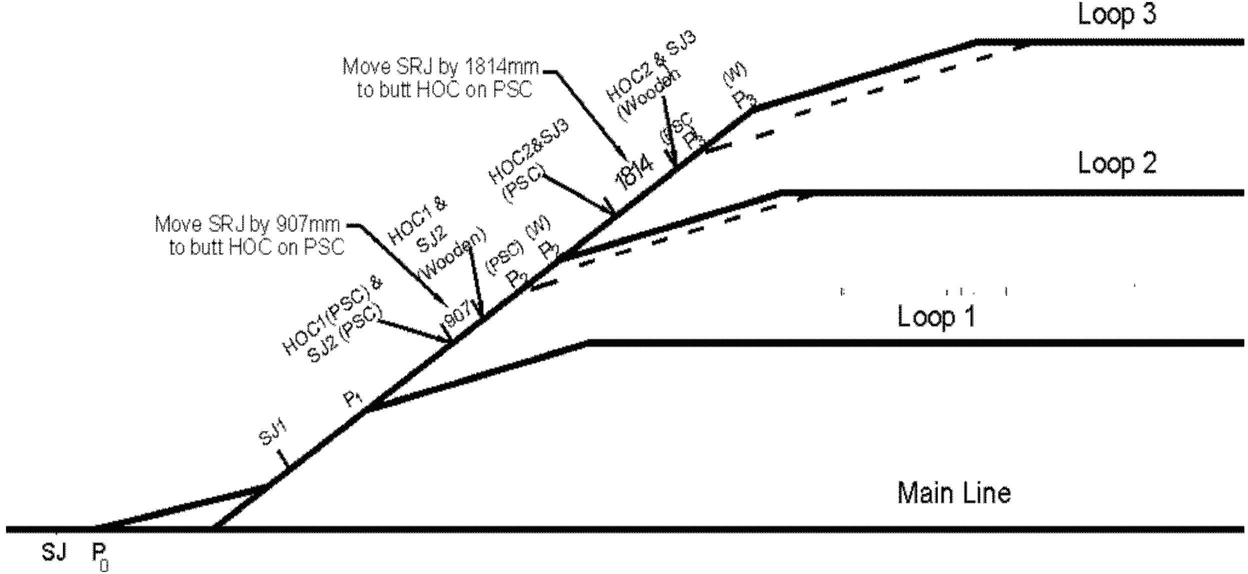


Fig. 2.16 Ladder arrangement while keeping same limiting angle but with shifting of SRJ to HOC.

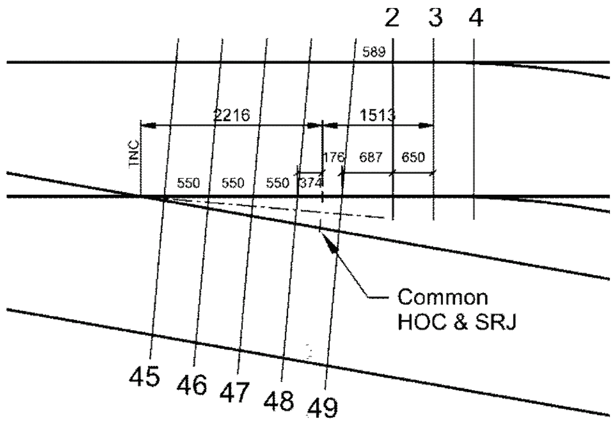


Fig. 2.17 Sleeper arrangement in case (a)

b) Keeping the same limiting angle and shifting alternate SRJ location (fig. 2.18).: In such cases, the SRJ of the alternate turnouts are moved to match the location of HOC. This will necessitate provision of rail piece of length 1814mm on alternate SRJs (Fig. 2.18). This will facilitate better spacing of sleepers between HOC and SRJ. Although rail piece of 1814mm is longer

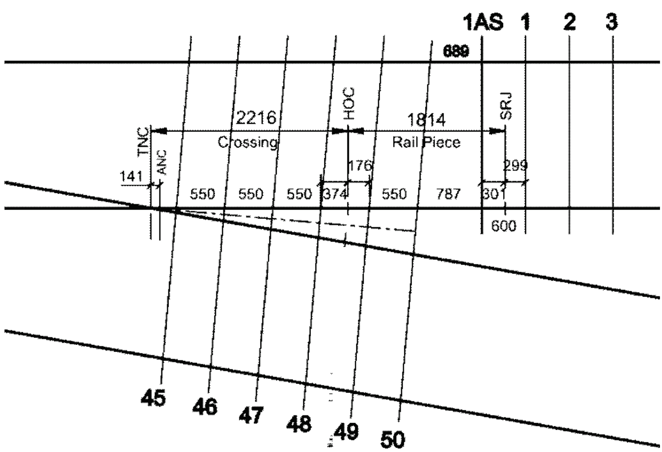


Fig. 2.19 Sleeper arrangement in case (b)

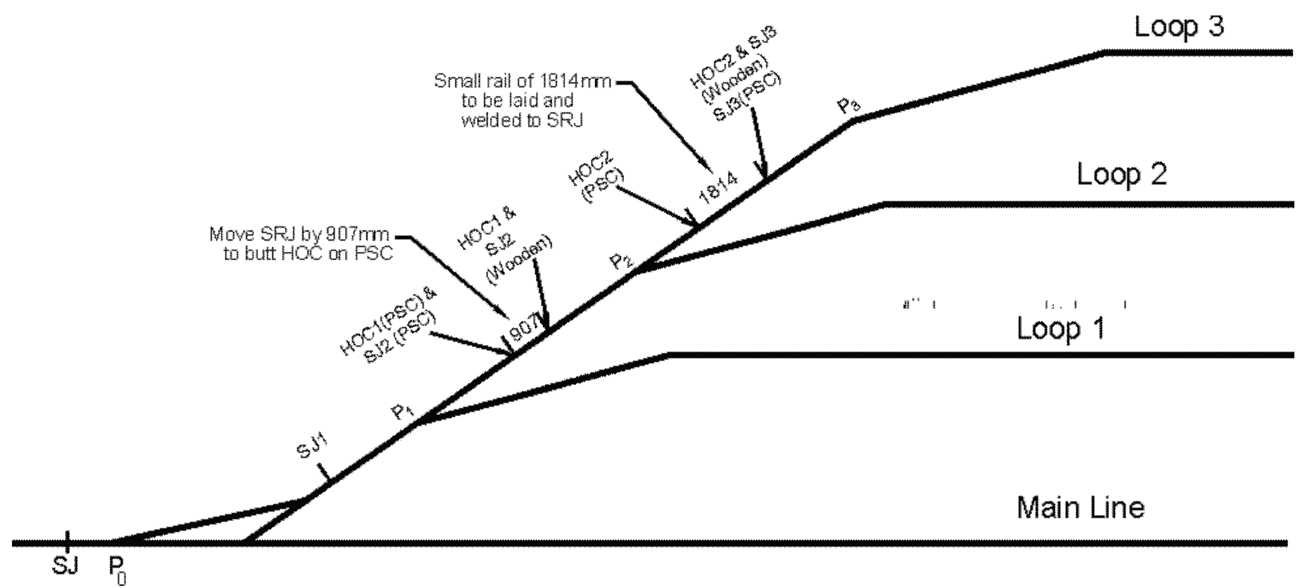


Fig. 2.18 Ladder arrangement while keeping same limiting angle and shifting alternate SRJ

than 907mm but still it is quite small. So keeping it fish plated at SRJ may lead to unsafe condition so the best practice would be to weld it at SRJ while keeping it fish plated with the CMS crossing. In this case, the best possible arrangement of sleepers between HOC and SRJ has been shown in Fig 2.19. In this case SRJs of turnouts leading towards loop number 2, 4, 6 and so, will be required to be moved by 907mm, but the SRJs of turnouts leading towards loop number 3, 5, 7 and so on will be kept at the same location.

c) Change of limiting angle of ladder: Because of less over all length of fan shaped layout on PSC sleepers, sharper limiting angle is possible with CMS crossings. If it is possible to change the angle of ladder the problem of small rail piece can be eliminated although this is a tough job. But one very important factor to be remembered in this case is that the minimum distance possible for first loop from main line is more for the ladder with PSC sleepers as compared to wooden layout. Hence the location of all the loops may have to be shifted in few cases, so this solution is almost impossible in open line. But in case old ladder is either already placed at sufficient distance or is having turn in curve radius more than 265m, the first and subsequent loops can be kept at the same location, but the radius of connecting curve immediately after heel of crossing on main line may have to be sharpened to 220m. So this kind of possibilities can be checked before deciding the solution to be used. The best possible arrangement of sleepers between heel of crossing and SRJ will be same as case (a) (can been seen in fig 2.17).

d) Use of welded heat treated crossing: As the length of welded heat treated crossing is equal to normal built up crossing, welded heat treated crossings may be used on ladder. In this case no modification to layout is required. This provides the easiest solution.

2.4.8 No change in grade near point & crossing: "There must be no change of grades within 30 meters of any points and crossings." (Note e(3) below para2: chapter- II station yards of IRSOD (BG) 2004)

2.5 Improvement to the non standard diamond crossing with the help of Polaris (A new concept of design of diamond crossing): Diamond crossings are used at a place where two tracks cross each other. On Indian Railways, diamond crossings sharper than 1:8.5 are normally not used. But at many locations sharper diamond crossings are required because of geometrical constraints. RDSO has standardized the diamond crossings of angle of 1:8.5. Hence for the locations where tracks are crossing each other at sharper angle, standard designs are not available. For the crossing of track at sharper angle, discontinuity of rail table becomes an important factor. Following difficulties are experienced on such sharper diamond crossings-

1. Because of discontinuity in rail head, jerk is experienced by the vehicle while passing over it.
2. Because of heavy impact caused by vehicle (because of discontinuity of head) packing gets loosened very frequently. If loose packing is not promptly attended it further leads to rough running and lowering of joint.
3. Wear and tear of component of special diamond is extremely fast. Rails, check rails and bolts are required to be replaced frequently.

Due to the issues discussed above, very restrictive speed (10 to 30kmph) is permitted over such special diamond crossings. Crossings at such sharp angle are available at Bhusaval and Nagpur yard on Central Railway. In Bhusaval yard tracks are crossings each other at 54°12'40", necessitating speed restriction of 15kmph on Mumbai-Howrah route. Apart from slowing down the traffic, breakages of this diamond crossing components were also very frequent requiring regular attention and replacement.

At this location the conventional diamond crossing have been replaced by a special diamond crossing of new design called **"Polaris"**. This has helped to not only to raise the speed to 75kmph on Mumbai-Howrah route, but the breakages of diamond crossing components have also reduced drastically. One of the tracks of this crossing belongs to Mumbai-Howrah route, the other track belongs to chord line. Very few trains are normally passing on chord line, hence the rail table of chord line has been raised on approach of diamond crossing to such an extent that the wheel flanges of wagon going along chord line are raised to the top level of rail of ML, so that it can run over main line track. The discontinuity of main line rail table has been eliminated in this process. This is called run over concept. Since the maximum depth of flange on Indian Railways is 35mm, the chord line has been raised by 32mm. In order to provide ramp to the wheel passing on chord line, the load of wheel is transferred to the distance block through the wheel flange. This distance block is provided in a ramp shape so that the flange reaches to rail top level (fig. 2.20).

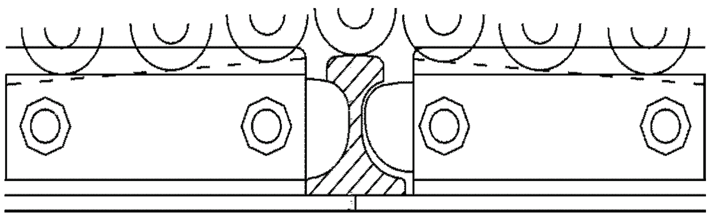


Fig. 2.20 Ramp for transfer of wheel load to flange

The actual design of such crossing will have to be location specific. However, for diamond crossing at Bhusaval where the crossing angle is 54°12’40” a total discontinuity of 170mm was required to be provided. Out of this 170mm, 40mm was required for flange way clearance; 67mm was the head width of rail (main line) and 63 for clearance required for wheel disc on non gauge face side. After running over the main line track and passing the 40mm flange way clearance, the wheel tread finds another block to support it. This web block is provided with ramp and it transfers load from wheel flange to wheel tread.

This complete assembly is fixed on a specially designed base plate. The structure supporting mainline has been isolated from branch line, so as to avoid transfer of load and vibration from one line to another. The discontinuous pieces of rail for branch line are also properly fixed to base plate.

Such arrangements have resulted into a upgradation of speed to 75kmph (from 15kmph) on main line. The traffic on main line has eased out because of this innovation. Maintenance effort required for maintenance of this diamond crossing is very less as compared to conventional design. Hence this design is very beneficial to the railways. Similar design has also been provided successfuly at Nagpur also.

Fig. 2.21 Continuous rail of main line

2.6 Do's for laying of turn out

1. Check the availability of all components as per check list before laying in field.
2. Arrange switch and crossing of required rail section and crossing angle.
3. Decide on the method of laying depending upon land and T-28 machine availability.
4. Lay approach and exit sleepers in proper sequence.
5. Before marking the SRJ locations please check the overall length required.
6. Pre curvature of tongue and stock rail to be checked before laying and corrected if required.
7. Ensure minimum throw of switch (115 mm).
8. Ensure full compliment of fittings.
9. Ensure gapless joint at heel of switch and crossing.
10. Ensure proper fixing of spherical/taper washer.
11. In case of 52 kg. track on turnout, liners of proper design to be used.

12. Ensure proper setting of spring setting device.

13. Ensure sleepers spacing as per RDSO drawing for straight main line. For curved main line follow the suitable modified spacing as per annexure in chapter 6.

2.7 Works required before interlocking: Before interlocking work is taken in hand, the SSE/Pway should

(a) Bring the rails to correct level and alignment.

(b) Fully pack and ballast the points to be interlocked.

(c) Provide creep indicators if required.

(d) Mark places where the rods and wires have to cross the lines.

(e) To avoid future adjustments of gear, see that the Permanent Way at points, is laid to correct gauge so that switches, fittings and locks may be correctly put together.

(f) Clear formation and bring it to the correct level and section where rods and wires have to be run.

(g) Make the road at level crossings, if any to correct level and section to allow casing pipes for wires to be put in their final position.

(h) Provide and fix special timbers as may be required.

(i) Fit gauge tie plates correctly to all switches.

As interlocked points should be disturbed as little as possible, it is of the utmost importance that these instructions should be rigidly adhered to.

In the case of interlocked points, the Signal Inspector will be responsible for keeping in working order the interlocking parts and apparatus. As the slewing of the track at points is likely to throw them out of adjustment, such work should not be undertaken except in the presence of the Signal staff.

On the advice of track defects from Signal Inspectors, Permanent Way Inspector should promptly attend to them.

2.8 Display of date of laying of points & crossings

The month and year of laying a new or second hand points and crossings should be painted in white block letters on the webs of switches about 500 mm from the heel joint and the webs of crossings about 500mm from the joint connected to the lead rails.

When second hand points and crossings are subsequently laid at another site, the dates previously marked should not be obliterated; an indication of the total life will then be available. In the case of reconditioning of switches and crossings, the date of reconditioning should also be painted.

Spacing of 1 in 12 Turn - out Sleepers
(Refer Fig 2.22)

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
	150	
1		150
	457	
2		607
	510	
3		1117
	695	
4		1812
	537	
5		2349
	550	
6		2899
	550	
7		3449
	550	
8		3999
	550	
9		4549
	550	
10		5099
	550	
11		5649
	550	
12		6199
	550	
13		6749
	550	
14		7299
	550	
15		7849
	550	
16		8399

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
	550	
17		8949
	550	
18		9499
	550	
19		10049
	550	
20		10599
	526	
21		11125
	548	
22		11673
	549	
23		12222
	549	
24		12771
	549	
25		13320
	549	
26		13869
	549	
27		14418
	548	
28		14966
	549	
29		15515
	549	
30		16064
	549	
31		16613
	549	
32		17162

Spacing of 1 in 12 Turn - out Sleepers
(Refer Fig 2.22)

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
	549	
33		17711
	549	
34		18260
	549	
35		18809
	549	
36		19358
	548	
37		19906
	548	
38		20454
	549	
39		21003
	549	
40		21552
	549	
41		22101
	549	
42		22650
	549	
43		23199
	549	
44		23748
	549	
45		24297
	549	
46		24846
	549	
47		25395
	549	
48		25944

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
	549	
49		26493
	549	
50		27042
	549	
51		27591
	549	
52		28140
	549	
53		28689
	549	
54		29238
	549	
55		29787
	549	
56		30336
	549	
57		30885
	549	
58		31434
	549	
59		31983
	549	
60		32532
	548	
61		33080
	549	
62		33629
	549	
63		34178
	549	
64		34727

Spacing of 1 in 12 Turn - out Sleepers
(Refer Fig 2.22)

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
	549	
65		35276
	550	
66		35826
	550	
67		36376
	550	
68		36926
	550	
69		37476
	550	
70		38026
	550	
71		38576
	550	
72		39126
	550	
73		39676
	550	
74		40226

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
	550	
75		40776
	550	
76		41326
	550	
77		41876
	550	
78		42426
	550	
79		42976
	550	
80		43526
	550	
81		44076
	550	
82		44626
	550	
83		45176

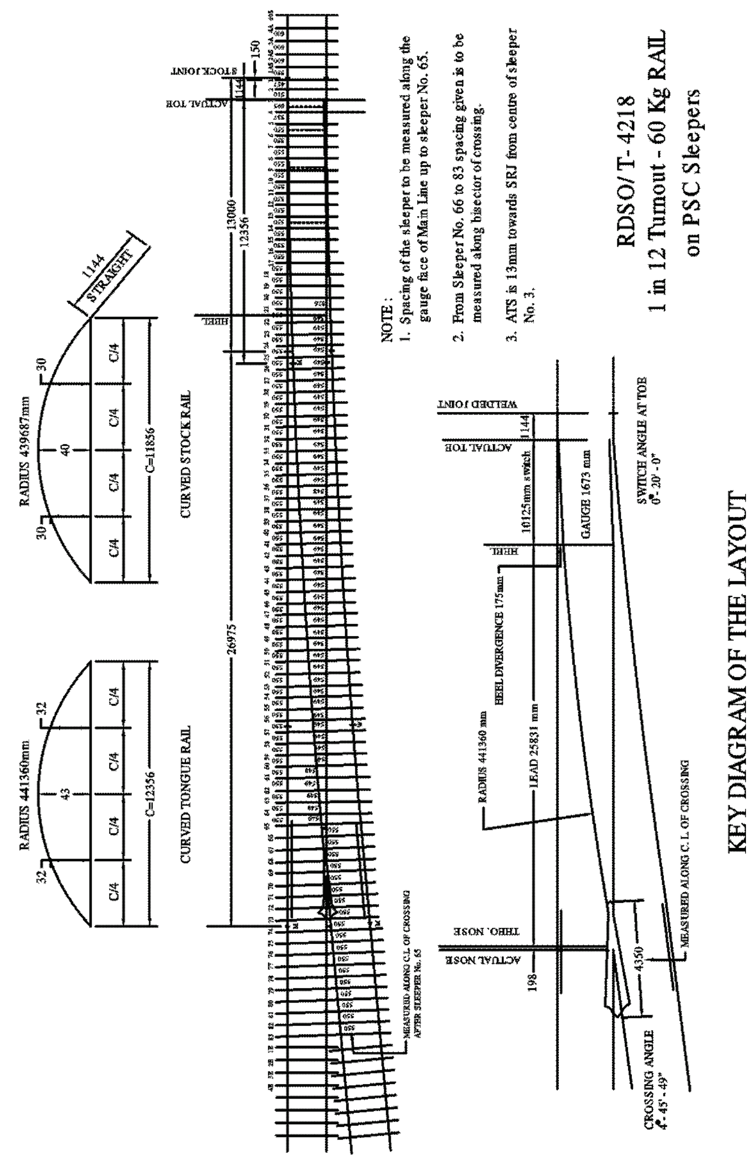


Fig. 2.22 Laying of sleepers, 1 in 12 turnout

Spacing of 1 in 8.5 Turn - out Sleepers (Refer Fig 2.23)

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
	268	
1		268
	600	
2		868
	605	
3		1473
	695	
4		2168
	605	
5		2773
	660	
6		3433
	600	
7		4033
	600	
8		4633
	600	
9		5233
	600	
10		5833
	600	
11		6433
	600	
12		7033
	600	
13		7633
	564	
14		8197
	597	
15		8794
	597	
16		9391
	598	
17		9989
	598	

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
18		10587
	597	
19		11184
	598	
20		11782
	598	
21		12380
	598	
22		12978
	597	
23		13575
	598	
24		14173
	598	
25		14771
	598	
26		15369
	597	
27		15966
	598	
28		16564
	598	
29		17162
	598	
30		17760
	597	
31		18357
	598	
32		18955
	598	
33		19553
	597	
34		20150
	598	
35		20748

Spacing of 1 in 8.5 Turn - out Sleepers
(Refer Fig 2.23)

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
	598	
36		21346
	598	
37		21944
	598	
38		22542
	597	
39		23139
	598	
40		23737
	598	
41		24335
	598	
42		24933
	550	
43		25483
	550	
44		26033
	550	
45		26583
	550	
46		27133

Distance from SRJ		
Sleeper no	Individual spacing	cumulative
	550	
47		27683
	550	
48		28233
	550	
49		28783
	550	
50		29333
	550	
51		29883
	550	
52		30433
	550	
53		30983
	550	
54		31533

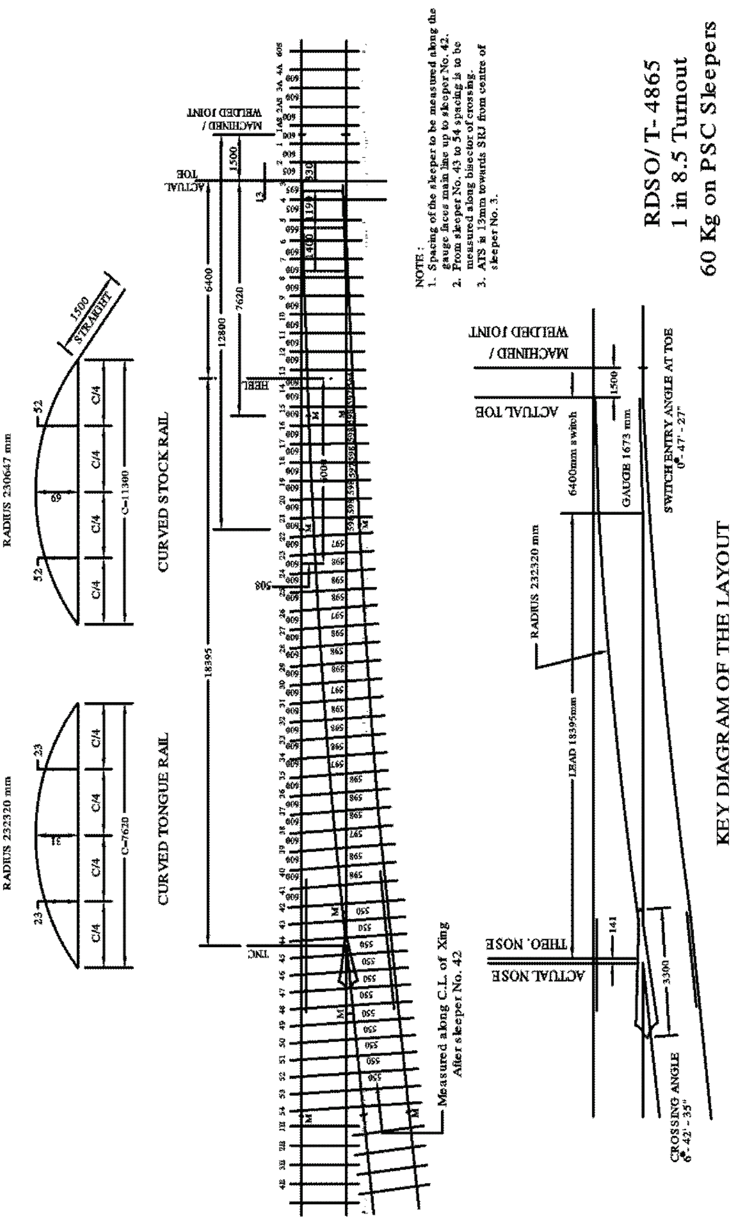


Fig. 2.23 Laying of sleepers, 1 in 8.5 turnout

Spacing of 1 in 8.5 Symmetrical split Turn - out Sleepers (Refer Fig 2.24)

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
	268	
1		268
	600	
2		868
	605	
3		1473
	695	
4		2168
	605	
5		2773
	660	
6		3433
	600	
7		4033
	600	
8		4633
	600	
9		5233
	600	
10		5833
	600	
11		6433
	600	
12		7033
	600	
13		7633
	600	
14		8233
	600	
15		8833
	600	
16		9433
	580	
17		10013
	600	

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
18		10613
	600	
19		11213
	600	
20		11813
	600	
21		12413
	600	
22		13013
	600	
23		13613
	590	
24		14203
	600	
25		14803
	600	
26		15403
	600	
27		16003
	600	
28		16603
	600	
29		17203
	600	
30		17803
	600	
31		18403
	600	
32		19003
	590	
33		19593
	600	
34		20193
	600	
35		20793

Spacing of 1 in 8.5 Symmetrical split Turn - out Sleepers (Refer Fig 2.24)

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
	600	
36		21393
	600	
37		21993
	590	
38		22583
	600	
39		23183
	600	
40		23783
	600	
41		24383
	590	
42		24973
	517	
43		25490
	550	
44		26040
	550	

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
45		26590
	550	
46		27140
	550	
47		27690
	550	
48		28240
	550	
49		28790
	550	
50		29340
	550	
51		29890
	550	
52		30440
	550	
53		30990
	550	
54		31540

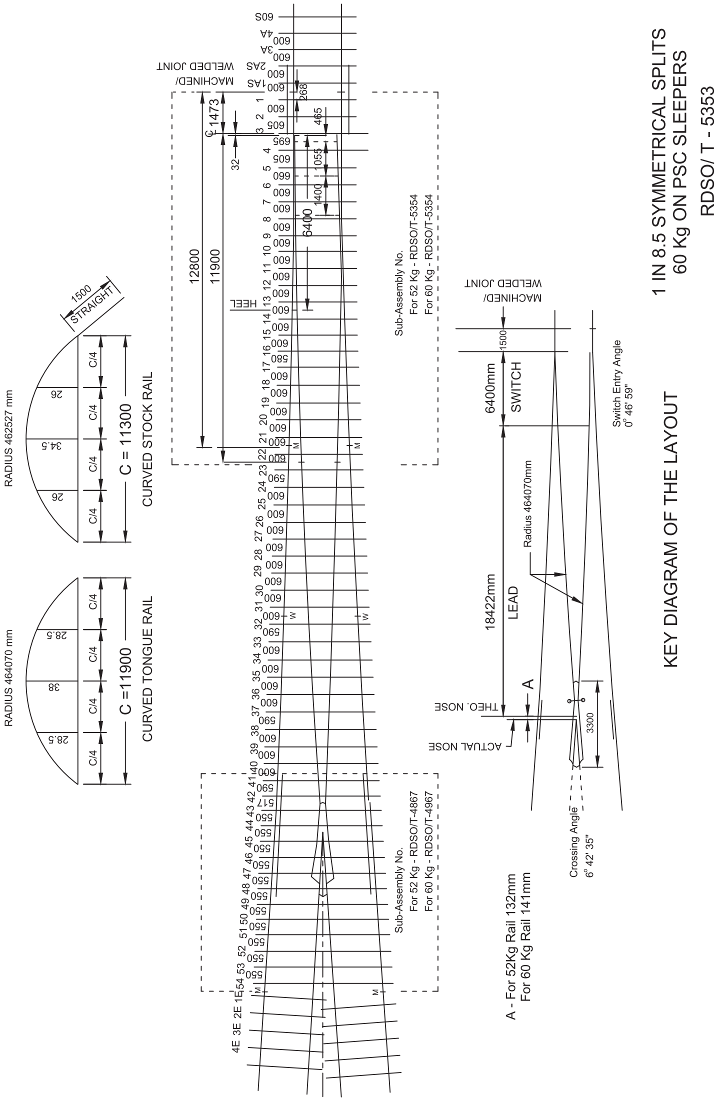


Fig. 2.24 Laying of sleepers, 1 in 8.5 symmetrical split

■ ■ ■

CHAPTER 3

INSPECTION OF POINTS AND CROSSINGS

3.0 General: Attempt has been made in this chapter to explain the proper process of measurement of point and crossing and their tolerances, as applicable.

3.1 Paint marking of locations where measurements are to be done: Inspection of points and crossings involves rigorous measurements at many places on the turnout. For the ease of inspecting officials, it is recommended that the locations on which measurement are to be taken, may be marked by paint on the rail with different colour (optional) such as,

1) Locations where wear of tongue rail, stock rail and crossing are to be measured may be marked with one colour (red).
2) Locations where gauge, cross level, alignment (versine) or straightness are to be measured in the switch, lead and crossing may be marked with some other colour (blue).
3) Locations where clearances of checkrails, wing rails are to be measured may be painted with different colour (white).

With the help of markings in different colours at different locations, measurement of turnout becomes relatively easiy. In case more than one measurement are to be taken at one place, vertical strips of corresponding colours may be marked side by side at that location to facilitate measurement.

3.2 Inspection schedule of points and crossings: Points and crossing are inspected in 2 different ways -

1. Inspection by engineering officials (Incharge SSE/ (Pway), JE (Pway) or AEN)
2. Joint inspection of points and crossings by SSE/ (Pway), and SSE/ (Signal).

3.2.1 Inspection by engineering official: The turnouts are required to be inspected as per schedule given below:

a) Inspection by Divisional Engineer : Should isnspect certain numbers of point and crossings particularly in running lines and those recommended for renewals

c) Inspection by AEN: Turnouts on the passenger running line are to be inspected once in a year and on the other lines 10% of the points and crossing.

c) Inspection by SSE/P.Way in overall charge and his assistant: SSE/P.Way in overall charge and his assistant should carry out the inspection of points and crossings in passenger running lines once in three months by rotation and on other lines and yards lines once in six months by rotation. However for Points and crossing laid on PSC sleepers, the detailed inspection as per Para 429 (5) (Annexure 4/3 IRPWM) should be done once in year and all other in between inspections should be carried out as per proforma given in Annexure 4/3 IRPWM. The proforma as given in Annexure 4/3 IRPWM is relatively small as compared to the old detailed proforma, since it contains only those items which are prone to frequent changes.

3.2.2 Joint inspection of point and crossing: Such inspections are done only for the interlocked points once in quarter. In this inspection focus is on switch area only. There is no universal format available for joint inspection of point and crossing. However following items are inspected in joint inspection by PWI/APWI and CSI/SI as per format available in few railways:

1. Condition of tongue rail LH/RH (Whether needs replacement?, floating condition).
2. Condition of packing and drainage in switch (Whether it needs improvement?)
3. Condition of sleeper in switch

4. Housing of switch Rail with stock rail (minimum 4 sleepers for 1 in 12 turnout and 3 sleepers for 1 in 8.5 turnout on PSC layout (adjusted by jim crowing).
5. Whether tongue Rails are square. (more than 15mm out of square to be corrected).
6. Condition of stock rail LH/RH.
7. Condition and adequacy of Engineering fittings. (Stud Bolts, Chair Plates, Welding of Chair Plates, etc.
8. Whether any burr on stock/tongue rail obstructing the movement of lock bar/housing of Switch etc.?
9. Throw of switches at ATS in mm (min. 115$\pm$3mm for BG and 100mm for MG for normal switch, min. 160mm for thick web switch.
10. The clearance between top of leading stretcher bar and bottom of rail. (between 1.5mm to 5mm)
11. Obstruction test with 5 mm test piece (OK or Requires adjustment).
12. Nuts & bolts provided are of standard size and are in tight condition or not.
13. Whether stock joint fishplate is machined for smooth working of lock bars.?
14. Gauge tie plate is of standard size, slide chair fixing nuts/bolts are tight.
15. Track gauge and level is proper.
16. Condition of point machine

a) Whether point machine free from any obstruction (dust, rust or any foreign materials and corrosion)?
Painting required or not?

b) Make and age of motor:

(7 years for suburban/ 12 years for A & B routes/ 15 years for D & D Spl routes.

c) Whether point machine is provided with suitable gaskets and wire entrances sealed to make them water tight and dust proof. [All the extra opening shall be closed as far as possible]

d) Whether motor armature is clear and free from carbon deposits?

e) Whether point motor insulation and switch bracket insulation is proper?

17. Operation of point machine

a) Whether any unusual noise observed while operating?

b) Stroke of the point machine

143mm for IRS /Siemens

220mm for IRS clamp type

c) Whether operating current is proper?

1.2 – 1.5 A for IRS/Siemens

4.3 A for IRS clamp type

d) Obstruction test by 5mm piece @150mm from ATS

i. Point lock plunger shall not be locked

ii. Point detector contacts should not assume the position indicating point closure and

iii Friction clutch should slip

e) Slipping current

Upper limit shall not be more than 1.5 to 2 times of normal working current & Lower limit 0.5 A less than normal working current. (Any difference between normal operating current and operating current under obstruction is less than 0.5 A, machine to be replaced)

18. Functioning of locking arrangement

a) Square ness of lock with reference stretcher bar wherever facing point lock is provided

b) Completing locking of both stretcher bar of plunger of FPL (Facing Plunger Lock) wherever existing

19. Condition of rodding including ground connections

a) Whether any play is experienced in pull rod while operating? Whether any hill mark is available?

b) Whether driving rod is having clearance from rail bottom of 25mm to 40mm or not.

c) Whether rod renewal required due to excess corrosion or not

d) Whether fitting of rod arrangements are intact or not.

e) Lead wires having twist or bent and free from rail, sleeper and ballast etc.

20. Condition of insulation joints at track circuited points

a) (Glued joint/block joints)

b) Condition of insulation joints at Gauge tie plate, stretcher bar etc.

21. Interlocking apparatus and release lock is proper or not after housing of point (FPL) (Facing Plunger Lock)

22. Full complements of bolts and nuts at connections at stretcher bar / extension pieces.

23. Condition of lubrication of points

24. Condition of lubrication of slide chairs

25. General

a) Whether sleepers are properly positioned with rodding cross run cross the track

b) Any other item/deficiency

To avoid contradictions in the signaling manual and IRPWM, it is recommended that format of this register be decided jointly by CTE with CSTE of the zonal railways for uniformity as well as to rationalize proforma considering all the relevant items belonging to engineering as well as signaling department which may contribute to failure of point.

For Sample copy a Joint Inspection See Table 3.1

Tabel : 3.1

Joint Inspection of Point and Crossing

Section/Station : Operating Station :
Point no :
Location :
Rail Section :
Sleeper/ Assembly Type :
Angle of Crossing :
Laid on straight/ Curve :
Date of Laying :
Date of Inspection : Entry Date :

S.No.	Inspection Details	Obser-vation	Date of Compliance
1	Condition of Tongue Rail a) Left Hand Tongue Rail b) Right Hand Tongue Rail		
2	Condition of Stock Rail a) Left Hand Stock Rail b) Right Hand Stock Rail		
3	Condition of Packing of point layout with or without at M.S.P4 Housing of Switch Rail with Stock Rail with no excessive spring a) Left Hand Housing b) Right Hand Housing		
5	Condition, Adequacy and Tightness of Complete Fittings		
6	Tongue Rail out of Square		
7	Burr on Stock/Tongue Rail		
8	Creep/Switch Anchors, Rail Pegs and Level Pillers		
9	Opening of Switch at Toe		
10	a) Clearance between leading stretcher & bottom of rail b) Nut-Bolts at Leading Stretcher Bar and Bottom of Rail		
11	Gauge at Toe of Switch		
12	a) Heel Block Fish Plates b) Heel Block Fish Plates Offset		
13	Plained through Stock Joint Fish Plates		
14	Obstruction test with 5 mm test piece		

15	a) Is point equipment installed b) Condition of sleepers on which point equipment is installed		
16	a) Gauge Tie Plate is of standard size b) Chair Plate fixing Nuts/Bolts are tight c) No gap between M.S. strap revetted on Gauge Tie Plate and ChairPlate		
17	Whether Sleeper is secured by Tie Bar with Stock Rail		
General			
a b c	Whether sleepers are properly positioned with rodding run & wire run crosses the track If point zone is track circuited Any other item		

Signature JE/SSE (Signal) with Date   Signature of JE/SSE (P. Way) with Date

3.3 Proforma for inspection of points and crossing by engineering officials: There are 2 proformas for inspection of turnout. One for the detailed inspection, which is to be used once in a year and the other to be used for intermediate inspections on PSC turnouts. Proforma for detailed inspection of point and crossing along with explanation and tolerance for various items have been shown on Table 3.2. It may be noted that for many parameters tolerance are not written clearly in IRPWM, hence tolerance for few readings have been derived, which may not be treated as mandatory, however these may help to maintain point and crossing in a better way. At many places standard/designed value of gauge, cross level and versine have been derived from standard profiles.

An Intermediate inspection of points and crossing (As per TMS) is shown in Table 3.3

RDSO has issued separate proforma for thick web switch vide letter no. ….where nominal gauge is to be taken as 1676 however for PSC layout the gauge should be maintained as 1673 to the extent possible.

Tabel : 3.2

Proforma for Inspection of Points and Crossings	**Remarks**
Station : Point No. Location : Rail section : Type of sleeper/assembly Angle of crossing :	
Nominal gauge of turnout	For PSC sleepers - 1673mm. For other than PSC sleepers-- 1676mm.
Left hand or right hand	
Laid on straight or on curve of radius	
Similar/contrary flexure :	
Date of laying sleeper (mm/yyyy)	
Type of crossing	
Detail of deep screening Date (mm/yyyy) I II III IV	
Manual/Mechanized	
Date of laying new/reconditioned crossing (mm/yyyy) I II III IV	Date of reconditioning may be painted on crossing Every switch/xing to be given a unique number and GMT carried on those may be monitored though register maintained in reconditioning depot.

Crossing unique number	
Manufacturer	
Date of laying new/ reconditioned switch (mm/yyyy)	It is required to monitor GMT taken by switch in track.
LH : I II III IV	
RH: I II III IV	
Particulars	
I. General	
1. Condtion of ballast and drainage in turnout (Clean cushion to be measured only once in a year)	
II Switch assembly and lead	
2. Condition of sleepers, slide chairs, plate screws, heel & distance blocks, other fittings of switch including tightness of bolts etc.	
3. Condition of tongue rails : LH RH	
a) Whether chipped or cracked over 200 mm length within 1000 mm from AT	Check if it is chipped/ cracked over small Slengths aggregating to 200 mm within a distance of 1000 mm from its toe. Chipped length will be portion where tongue rail has worn out for a depth of more than 10 mm over a continuous length of 10 mm.

b) Whether twisted or bent (causing gap of 5 mm or more at toe)	Check it is badly twisted or bent and does not house properly against the stock rail causing a gap of 5 mm or more at the toe, the limit described in the IRSEM.
c) Remarks over condition of tongue rail, whether requires reconditioning or replacement	Decision based on overall condition and remarks against (a) and (b) to be taken.
4. Condition of Stock, rail, burr formation to be mentioned specifically	
5. Creep and squareness of tongue rail at toe of switch	
6. Straightness of straight stock rail if laid on straight (Measured on 7.5 m chord)	The tolerance may be guided by the parameters given in Para 607(2).
7. Packing conditions under the switch assembly (preferably to be observed under traffic)	
8. Throw of switch LH RH	For new work 115mm (min.) For existing work 95 (min.)
9. Housing of stock and tongue rails: LH RH	In many Railways this has been legislated by CTE/Joint circular between CTE and CSTE
10. Gap between top edge of leading stretcher bar and bottom of rail foot : LH RH	Range 1.5 to 3.0 mm.

11. Working of SSD (if provided)	
12. Gauge and cross level in switch and lead	
a) At 450 mm ahead of toe of switch	Nominal gauge is expected.
b) At ATS between two stock rails	For 1 in 12/1 in 16/1 in 20 on PSC or 1 in 12, 60kg. on wooden sleeper- nominal gauge. For other turnouts---- nominal gauge + 6mm
c) Gauge and cross level for ML and turnout side. Versine of stock rail for turnout side upto end of lead.	

Station	G XL	Ve	
0			On PSC sleeper last station for 1 in 12 will be station No.11 & for 1 in 8.5 will be station No.7
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			

1) Station no. 0 to be marked at heel of switch for straight switch and at ATS for curved switches. Subsequent stations shall be marked at every 3m. Versines to be recorded on 6m chord length commencing from station no.1	
2) Versine reading shall be taken for turnout side except for symmentrical split turnout where it shall be taken on main line side.	
3) In case of gap between T/R and S/R, that should be added to gauge measurement.	
III. Crossing Assembly	
13. Condition of crossing a) Sign of propagation of crack (if any) in crossing assembly. b) Burning on top surface at nose : c) In case of Heat-treated welded crossing, Weld texture on top surface. If any flow or separation of weld portion : d) Tightness of bolts at CI/ distance block at toe, heel & nose of crossing as applicable. e) Condition of gapless joints.	

14. Wear of crossing (to be *In case of welded heat measured with straight edge at 100 mm from ANC) For CMS crossing, Actual wear for 52 kg. section = measured wear - 2.0 mm & Actual wear for 60 kg. section = measured wear - 2.5 mm.	treated crossing measured wear is to be deducted by a value to be checked from drawing (normally 3.5 mm) to arrive at actual wear. *Applicable for Wing rail as well as nose. *Maximum wear for nose & wing rail. **Rajdhani route :** 6 mm for built up/welded crossing, 8 mm for CMS crossing **Other route :** 10 mm. crossing
15. Gauge and cross level at	
a) 1 m ahead of ANC b) 150 mm behind ANC c) 1m. Behind ANC	FOR BOTH SIDE Gauge - nominal gauge, XL=0 for straight, on curve as per geometry.
16. Condition of check rail fitting eg. bearing plates, keys, blocks, bolts and elastic fastenings	
17. Clearance of check rails LH RH a) Opposite ANC : b) At 1st block towards toe of crossing and 1st block towards heel of crossing c) At the flared end towards heel and at the flared end towards toe	Clearance Range - not prescribed in manual minimum clearance 60 mm. Clearance Range - PSC Layout - 41 to 45 mm Other sleepers - 44 to 48 mm

<table>
<tr><td colspan="4">18. Clearance of wing rail (only for built up crossing.</td><td></td></tr>
<tr><td colspan="4">IV Turn in curve</td><td></td></tr>
<tr><td colspan="4">19. Turn in curve - Stations to be marked at 3m. Interval. Versines to be measured on 6m. Chord station No.0 to be marked at the centre of last long sleeper in case of PSC sleepers otherwise at heel of crossing.</td><td></td></tr>
<tr><td>STATION NO.</td><td>Ve</td><td>G</td><td>XL</td><td rowspan="9"></td></tr>
<tr><td>0</td><td>XX</td><td></td><td></td></tr>
<tr><td>1</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">20. Availability of 150 mm. additional ballast shoulder width on outside of turn in curve.</td><td></td></tr>
<tr><td colspan="4">V. General</td><td></td></tr>
<tr><td colspan="4">21. Any other special feature/ defects.</td><td></td></tr>
<tr><td colspan="4">22. Signature of the inspecting official with date.</td><td></td></tr>
<tr><td colspan="5">NOTE :
1) Locations where the gauge and cross levels are to be checked should be painted on the web of the rail.
2) The variation in versines on two successive stations in lead curve and turn in curve portions should not be more than 4 mm and versine at each station should also not be beyond ± 3 mm from its designed value</td></tr>
</table>

Tabel : 3.3

Intermediate Inspection of P&C (As per TMS)

1 Ballast details

1.1 Condition of Ballast

1.2 Condition of packing

1.3 Condition of Drainage

2 Condition of Switch AssemblyLeft Right

2.1 Whether chipped or cracked over 200mm length within 1000mm from ATS __________

3 Wear in Tongue rail & Stock rail__________

3.1 Tongue Rail at point with 13mm head width (As per annexure 2/6/1)

3.2 Stock Rail at point with 13mm head width (As per annexure 2/6/1)

Vertical	Lateral	Vertical	Lateral

4 Gauge & cross level in Switch Portion

4.1 At ATS between the two stock rails

4.2 At 150 mm behind toe of switch

For straight road		For Turnout	
Gauge	X-level	Gauge	X-level

5 Condition of crossing

5.1 sign of propagation of crack (if any)

5.2 Type of crossing

6 Wear of crossing

(to be measured with straight edge at 100mm from ANC)

Left wing rail	On nose	Right wing rail

(For CMS crossing)

Actual wear for 52 kg section = measured wear -2.0mm

Actual wear for 60 kg section = measured wear -2.5mm)

7 Condition of check rail fitting eg. Bearing plates, keys,bolts and elastic fastening _________________

8 Condition of welding of slide chairs and lugs _____

9 Condition of gapless joint in CMS xing___________

10 Remarks_______________________________________

■ ■ ■

CHAPTER 4

MAINTENANCE OF POINTS AND CROSSINGS

4.0 Maintenance general : Maintenance of point and crossing involves correction of track geometry as well as reconditioning of tongue rail, stock rail and crossing. Many fittings in turnout that become loose because of vibration, are to be tightened regularly. Apart from these regular maintenance lugs of slide chairs also break specially near ATS, which are to be welded from time to time. Important issues involved with maintenance of points and crossings are :-

(a) Points andcrossings should be laid without 1 In 20 cant unless otherwise specified in the drawing.

(b) Where large number of P & C are being maintained within a specific area such as marshalling yards, large lay-outs of sidings, terminal stations etc., regular cycle of maintenance covering all P & C should be organized.

(c) Cess level should be such as to permit efficient drainage and adequate depth of ballast cushion should be provided.

(d) Correct spacing of sleepers should be ensured according to the standard layout drawings.In case of turnouts taking offfrom curved track, modification in the spacing of sleepers shall be ensured.

(e) Use of spherical washers at appropriate places in a Points and Crossings assembly is very important. A spherical washer is used to obtain flush fit of the head of the nut of the bolt with the web of the rail, in the switch and crossing assembly. The use of spherical washer is necessary where the . shank of the bolt is not at right angles to the axis of the rail. Spherical washers are used on skew side In I.R.S. turnouts, these should be provided on the left hand side invariably in the switch assembly.

(f) Packing under the sleepers must not be loose/ defective especially under the crossing and the switch.

(g) The chairs and fastenings and all other fittings must be properly secured.

(h) The P and C assembly should be in good condition and alignment with the rest of the track without kinks.

(i) It is desirable to weld stock and lead joints on the P and C assembly.

4.1 Alteration to points : The position of P and C should not be altered nor should any be removed without the written authority of the Divisional Engineer. The sanction of the Commissioner of Railway Safety is necessary in the case of alterations/insertion/ removal of points and crossings in existing running lines, however shifting of points which do not affect nature of signaling, will not require CRS sanction.

4.2 Gauge and Super-elevation in Turnouts : It is a good practice to maintain uniform gauge over turnouts. Tolerance in gauge at various portions of turnout during new laying/renewal and maintenance shall be as follows:

<table>
<tr><th>Switch/Lead/ Crossing portion of turnout</th><th>New Laying/ Renewal</th><th>Maintenance</th></tr>
<tr><td>Switch portion</td><td rowspan="2">As per para 520(3) of IRPWM</td><td rowspan="2">As per para 525(1) of IRPWM</td></tr>
<tr><td>Lead portion</td></tr>
<tr><td>Crossing portion</td><td colspan="2">0 mm to 4 mm with respect to gauge prescribed in standard drawing is 1673 mm</td></tr>
</table>

(a) If gauge of track adjoining the points and crossings is maintained wider/tighter than the gauge on the P & C, the gauge on the adjoining track should be brought to same gauge as in the P & C, ***as a good maintenance practice.***

(b) Super-elevation on turnouts with curve of similar or contrary flexure should be provided in accordance with Paras 413 and 414 of IRPWM.

4.3 Removal of burr from stock rail and crossing: The clearance at the toe, heel of switch, at check rail and wing rail must be maintained within the tolerances prescribed in the schedule of dimensions. Turnouts are laid without cant, hence contact between wheel and rail is limited to very narrow strip near gauge face. This creates excessive contact stresses, which leads to metal flow in stock rail from gauge face and from non gauge face in tongue rail. This metal flow is called burr. Such burr may cause obstruction to tongue rail when pressed against Stock Rail. This may lead to chipping of tongue rail from the top. This chipping initiates from the non gauge face of tongue rail. To take care of such incidences grinding of gauge face of stock rail and non gauge face of tongue rail must be organised regularly to remove the burr. At present chiselling is being done to remove the burr at most of the occasions. Removal of burr by chiselling can be avoided by using grinders. It is also a fact that chiselling can not be done when burr is very small, so people tend to wait for such thin burr to grow; this delay can damage the tongue rail. Grinding can be done even when burr is very small. So it is a good practice to arrange periodical grinding of stock rail/tongue rail to remove burr.

Similarly, clearance provided between nose of crossing and the wing rail tends to reduce due to flow of metal (burr) in the crossing. So, regular grinding operation should be undertaken to remove such burr, with the help of grinder.

4.3.1 Rail profile grinder: For grinding of burr, 2 types of grinders are available in the market:

(a) Profile grinder and portable generator. Transportation, shifting and placement of such generator at safe location in the busy yard may be difficult. However, very good quality of grinding can be obtained with this type of grinder.

b) **Portable grinder Fig. 4.1:** This kind of grinder is battery driven and can be carried in briefcase. These are light weight. One battery can work for 1.5 to 2hrs. Hence 2 to 3 charged batteries may be required for operating it for the full day.

Depending on the workload, one should decide which particular equipment is to be used for grinding. However, if rechargeable battery operated grinder is opted; multiple batteries should be kept charged for the full day work.

Fig. 4.1 Portable grinder

4.4 Maintenance of Switches :

(a) The condition of stock & tongue rails should be carefully examined. Badly worn and damaged stock and tongue rails should be replaced by serviceable ones. A tongue rail may be classified as worn/damaged when -

  (i) It is chipped/cracked over small lengths aggregating to 200 mm within a distance of 1000 mm from its toe. Chipped length will be the portion where tongue rail has worn out for a depth of more than 10 mm over a continuous length of 10 mm.

  (ii) it has developed knife edged tip (thickness of top edge being less than 2 mm) over a length of more than 100mm any where upto a distance of 1000 mm from its toe.

(iii) it is badly twisted or bent and does not house properly against the stock rail causing a gap of 5mm or more at the toe, the limit described in the I.R.S.E.M. The tongue rail can, however, be reused after reconditioning of the broken/worn/ damaged tip by welding.

Burred stock rail likely to obstruct the lock bar, should be replaced, if necessary.

(b) Rail Gauge ties, rodding etc., hinder proper packing and ordinary beaters become ineffective. Yard gangs therefore, should use tamping bars at such locations.

(c) To check the housing of the tongue rail and also the throw of the switch, all non - interlocked points should be operated by hand lever and other points from the signal frame, when traffic permits doing so.' If the tongue rail is found to be not housing properly against the stock rail, the defect must be rectified by the Permanent Way Staff in case of non-interlocked points and jointly with signal and telecommunication staff, in case of interlocked or partially interlocked points.

(d) Tongue rail should bear evenly on all the slide chairs. This will be ensured when all the sleepers are packed properly.

(e) When the tongue rail is in closed position, it must bear evenly against distance studs or blocks.

(f) All bolts on switches should be kept tight.

(g) Slight wide gauge at the toe of switch over and above the required widening to house the tip of the tongue rail, may be adjusted by providing suitable steel packing between the web of the stock rail and the lug of the slide chair wherever feasible.

(h) Stretcher bars connected to the pull rod shall be maintained jointly by the Permanent Way Staff and the Signalling Staff. Other stretcher bars shall be maintained by the Permanent Way Inspector. Stretcher bars insulated for track circuit purposes shall not be interfered with unless signal staff are present. The gap between top of stretcher bar and bottom of rail should be between 1.5mm to 5mm.

(i) Wear on switches can be reduced by lubrication of the gauge face of tongue rail.

(j) For measuring versine in switch portion zero station should be marked at ATS for curved switch and versine for turnout recorded on stock rail on turnout side.

4.5 Maintenance of Crossings :

(a) If any damage to the nose of crossing is noticed, its cause must be traced, which may be due to tight gauge or due to excessive clearance at the check rail. To avoid hitting of nose, it shall be ensured that (Track gauge - check rail clearance) > (Maximum

Wheel gauge + Maximum flange width).

(b) If wing rails or check rails are badly worn laterally, it could be due to wide gauge at the crossing. To avoid such situation, (Track gauge - check rail clearance - wing rail clearance) < Minimum Wheel gauge. Gauge can be maintained properly by the provision of a gauge tie plate under the nose of crossing, on layout of wooden sleepers.

(c) In obtuse crossings, the distance between the throat and the nose must be maintained correctly.

(d) In diamond crossings, obtuse crossings should be laid square to each other with respect to the centre line of the acute crossings.

(e) Maximum permissible vertical wear on wing rails or nose of crossing shall be 10mm. However, on Rajdhani/ Shatabdi routes, as a good maintenance practice, crossing and the wing rails should be planned for reconditioning/resurfacing by welding on reaching the following wear limits: Built up/welded crossing - 6mm and CMS crossings- 8mm

Note:

(i) In case of CMS crossings, following dimensions should be deducted (to account for slope in casting of wing rails to 1 :20 cant) from the observed wear measurements to find out the actual wear. for 52 kg section : 2.0mm. and for 60 kg section : 2.5mm.

(ii) In case of welded heat treated crossings, the dimensions to be deducted from the observed wear for finding out actual wear is as shown on the relevant layout drawing.

4.6 Maintenance of lead portion and turn in curve :

(a) The leads and radii of turnout should be correct according to the section of the rail and the angle of crossing used.

(b) Initially, the lead curve correctness should be ensured by measuring offsets from the gauge face of the straight track. During maintenance, stations at 3.0 M intervals should be marked and the versines checked and track attended as necessary.

(c) The versines of turn in curves on loops should be recorded at stations at 3.0 M intervals on 6.0m chord length during the inspection of point and crossings to check the sharpness of the curve and rectified as necessary. The turn-in curve should also be checked for condition of sleepers and fastenings.

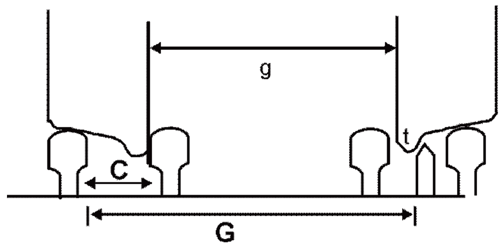
(d) The variation at each station should also not be beyond ± 3mm, from its designed value, **as a good maintenance practice.**

4.7 Construction of good drainage system and regular attention to drainage: As the hammering action on the turnout is particularly heavy, inefficient drainage may creates more problems on turnout as compared to other part of track. Yards particularly with multiple lines, suffer more from drainage problem. Condition of drainage is particularly bad on points and crossing in such big yards. So a good yard drainage plan should be made with special focus on turnout area.

Drains should be designed in such a way that its top level is below the cess level. Longitudinal drains should run in between lines. At suitable locations RCC pipes of 300mm or more diameter may be provided for crossing the tracks. At manholes cover, made of steel grills with smaller opening, should be provided to stop falling of ballast into drain/manhole. All such drains should be regularly cleaned to allow proper flow of water. In case because of construction of open drain in the yard, if it is not possible to provide ballast at shoulder, drain cover made of steel grill with small opening may be provided and only big pieces of ballast are laid directly over such cover. Ballast can be laid over it to provide shoulder ballast.

4.8 Clearance of wing rail and check rail opposite to nose of crossing (Fig. 4.2) : The clearance of checkrail should be maintained between 41 to 45mm on PSC sleepers, on other sleepers it is to be maintained between 44 to 48mm. The check rail clearance tends to increase on account of loosening of bolt or wear of check rail caused by rubbing action by back of wheel. In case of increase in clearance of check rail on account of loosening of bolt, the same should be tightened. Care should be taken that spring washers are always provided in the bolts, which reduces the incidences of bolt loosening because of vibration. In case, the increase in gap is on account of wear, the same can be adjusted by removing one of the two packing plates of 3.15mm thickness provided with the check block. Other packing plate may also be removed in future when further wear takes place. However, when both the packing plates have been removed and checkrail clearance is still reaching to 45mm, the check rail should be replaced with new/reconditioned one with both packing plates again provided along with check block between running rail and check rail. Hence the packing plates when removed from track should be preserved for future use.

The limit of maximum gap of check rail have been calculated for the most critical condition i.e. new wheel with thickness of 28.5mm and wheel gauge of 1600mm. However maximum wheel gauge permitted is 1602mm. In case both the critical conditions coming simultaneously i.e. new wheel with wheel gauge of 1602mm, accelerated wear of nose of crossing may take place, but such wheels are rarely running in track. Hence if the check rail clearance is maintained up to 43mm, it will reduce wear of crossing to some extent, but it may increase wear of check rail.



$C < G - g - t_{max,}$ $C < 1673 - 1600 - 28.5$

$C < 44.5mm$

Fig. 4.2 Maximum clearance of checkrail

4.9 Effect of creep on point and crossing: When the point and crossing are provided on the steeply graded section, creep is likely to be more at point and crossing because of several joints in the points and crossings adding to creep. Quality of gapless joint also has a role to play in reducing the amount of creep. As the tongue rails creep without sleeper movement, the bolts connecting stretcher bar to point machine start snapping. Hence creep of tongue rail should be regularly checked, especially for the turnouts laid on steep graded section. Experiences have shown that on the grades milder than 1 in 150 the problem of creep on point and crossing is quite manageable or negligible. For the turnouts on section with grade steeper than 1 in 150 proper markers should be fixed outside of track to record amount of creep. Creep posts should be erected at all interlocked facing points opposite the toe of the switch and creep should not be allowed to exceed permissible limits i.e. 15 mm (except curve) . In case of PSC sleeper layout if excessive creep is observed, the condition of elastic fastenings may be examined and suitable action be taken.

4.10 Avoid junction fish plates: Stock Rail Joints as well as joints at heel of crossing should never be provided with the junction fish plate. If at all there is a change in rail section, same rail section should be maintained for one rail on all the three sides of turnout. The junction joint formed can also be welded by appropriate thermit welding technique.

4.11 Cleaning and Lubrication of points: At all interlocked and partially interlocked stations, the Signal staff will be responsible for the periodical cleaning and lubrication of those slide chairs in which of signaling and interlocking gears are connected (generally upto third sleeper from toe of switch) in all points interlocked with signals or provided with locks. The Permanent Way Inspectors shall be responsible for the cleaning and lubrication of slide chairs of all. hand operated points on their sections and remaining slide chairs of all points interlocked with signals or provided with locks.

4.12 Reconditioning of points and crossings: Wear and tear of points and crossing components occurs much faster as compared to normal rail because of complicated nature of geometry and the wheel movement over different rails while negotiating point and crossing. The increased wear of points and crossing is on account of following reasons

(a) Non availability of cant of rail on point and crossing.

(b) Running of wheel on the reduced width on rail head in switch and crossing area.

(c) Negotiation of wheel from one rail to the other in the switch and crossing.

(d) Availability of fish plated joints on the turnouts.

(e) Train running on the cant deficiency on turnout side, hence wheels always tend to grind against outer rail. This results in more wear of outer rail and tongue rail.

(f) Tongue rail for turnout side is not tangential to the straight track. Wear and tear of tongue rail depends on switch entry angle.

Hence periodical reconditioning of tongue rail, stock rail and crossing is an important requirement to get the optimum life of the components along with smooth running. In case trains are allowed to run on components having wear beyond the prescribed limits, high level of stresses caused by passage of wheel may lead to development of cracks in the components. Hence timely reconditioning of point and crossing components is very important. Reconditioning of point and crossing has been dealt in detail in chapter 6.

4.13 Maintenance of track parameter: Distortion in track geometry on turnout is much faster because of presence of too many fish plated joints as well as diversion of wheel from one rail to other. Such irregularities create heavy impact forces in horizontal and vertical direction. Because of these reasons alignment, longitudinal level as well as cross level gets distorted very frequently. Further, there is a tendency in the field to repeatedly attend points and crossings by manual method, because of this reason turnout are found to be higher than approach track. Due to high rigidity of rail in horizontal direction and more weight in vertical direction as compared to a normal track, correction of alignment and cross level on the points and crossing is a difficult job. Hence turnout can be better attended by the mechanised means. On the Indian Railways, UNIMAT machines have been deployed for mechanised tamping of turnout. These are special machines designed to carryout tamping of points and crossings. For details on working of UNIMAT machine the relevant book and literature on machine working may be referred.

4.14 Special attention to turn in curves, which are following similar flexure turnout on mainline: This aspect is particularly important when the turnout is laid as similar flexure followed by a reverse curve. In such cases the cant on the main line is limited to 65mm. The super elevation on main line will act as negative super elevation on the turn in curve. The super elevation on such turn in curve can be reduced starting behind the crossing/last long sleeper at the rate of 2.8mm/m. On turn in curves stations are marked every 3m, hence the super elevation may be reduced up to the rate of 8.4mm per station situated at every 3m. So in practical terms one may reduce super elevation by 6 to 8mm on every station. The super elevation so designed should be written on rail at such stations. So train will be running practically on negative super elevation over this turn in curve; however rate of change of cant is limited by this action. Special care should be taken during maintenance of such turn in curve so as to not to create excessive twist. Care should also be taken while calculating the speed potential of train on the turn in curve keeping in view negative cant.

4.15 Do's for proper maintenance

1. Ensure proper gauge between stock rails at ATS.
2. Removal of burr from tongue, stock rails and crossing should be done periodically.
3. Do not allow the check rail clearance to exceed 45 mm for PSC sleepers.
4. Follow precautions as per 5.12 while packing turnout by UNIMAT machine.
5. Full turnout should be tamped in one block.
6. Third rail lifting arm must be used to ensure correct cross level.
7. Rodding at ATS should be removed while tamping to ensure better maintenance.
8. Follow correct squeezing depth and pressure of UNIMAT.
9. Rubber pad under crossing tend to fall with time. These rubber pad should be restored to proper place.
10. In case of similar flexure turnout followed by reverse curve, ensure that rate of change of super elevation does not exceed 2.8 mm/m.

4.16 Special provision and maintenance of signalling fixtures in track: IRPWM para 279 is reproduced below-

4.16.1 Provision of signalling fixtures in track

(a) No signal fixtures / installation which interfere with maintenance of track should be provided on track unless the approval for same is available from Track Directorate of RDSO or Railway Board.

(b) S&T department shall provide adequate number of personnel for opening of signal rod, gears etc. to facilitate mechanised track maintenance.

4.16.2 Precautions to be taken while working in track circuited area

(a) The JE/SSE(P.Way) should instruct the staff not to place across or touching two rails in the track, any tool or metal object which may cause short circuiting.

(b) All gauges, levels trolleys and lorries used in the track circuited length should be insulted.

(c) Steel or C.I. pipes used for carrying water / gas under the track should be run sufficiently below the rails to prevent any short circuiting.

(d) While carrying out the track maintenance, care should be taken to see that no damage of track circuit fittings like rail bonding wires, lead wires to rails, boot leg, jumper wires etc. takes place.

(e) Use of steel tapes should be avoided in track circuited section.

(f) Pulling back of rails should be done in track circuited areas in the presence of S&T staff, where signalling connections are involved.

(g) Proper drainage should be ensured so as to avoid flooding of track, during rains, particularly in yards, where watering of coaches is done and in water columns and ashpits. It would be desirable to provide washable concrete aprons on platform lines at originating stations, in track circuited areas.

(h) Ballast must be kept clean throughout the track circuited section and care should be taken to see that minimum ballast resistance per kilometer of track should not be less than 2ohms per km in station yard and 4 ohms per km in the block section as per Signal Engineering Manual Para 17.28. Wherever, PSC sleepers are used, availability of insulated liners upto a minimum level of 97% shall be ensured.

4.17 Deep Screening of Turnouts by BCM Machine: Normally the cleaning of points and crossing is to be done by BCM machine, however if there are constraints then one may resort to manual deep screening. The total ballast cushion should be 300 mm to facilitate deep screening by BCM. If ballast cushion is less than 300 mm, ballasting & lifting of the track should be done in advance using UNIMAT machine in consultation with S & T and TRD. If lifting of track requires increasing OHE height, feasibility of adjusting OHE is to be studied by TRD. If not feasible, TRD department should conduct survey for erecting new masts and submit the estimate for carrying out the work for inclusion in the Deep Screening Work. The estimate should be submitted initially to Engineering department at the time of sanction of work under revenue so that adequate time is available for fixing agency and for carrying out the work of erecting new mast or shifting of OHE mast wherever required.

The detailed methodology of working of BCM machine for deep screening of point and crossing including planning etc. may be seen in relevant chapter of track machine manual/other book. However important aspects related to associated works of S&T and TRD are described below.

4.17.1 Associated works of S & T department

i. The actual depth of the cable shall be ascertained by digging cable trench if they are crossing the track at the proposed portion of BCM to be worked. Cables coming across the track which are less than 0.75 meters depth from the rail flange level are to be identified in advance and if possible, they may be taken down to 1.0 m below the rail flange or they may be removed during the block time to avoid damage.

ii. Track circuit cables, Point cables, MSDAC cables & AFTC cables may have to be relocated, if necessary.

    Disconnection for the same will be required. Required disconnection has to be given for preliminary works and it may affect train movement on both the lines connected with the cross over.

iii. The Cable Termination Box Foundation shall be shifted 3.2 m away from the centre of the track so as to facilitate deep screening of complete turnout. This is very essential for carrying out the deep screening of sleeper No. 1, 2, 3 & 4 of the turnout by BCM. For shifting of Cable Termination Box Foundation, dismantling of existing Cable Termination Box Foundation will be required for removing the infringement which may have repercussion on traffic.

iv. To carry out S&T preliminary works, the sufficient S&T staff are to be deputed at each site at least one day in advance of block as required as per site conditions. S&T staff should fully equip themselves to attend the block with adequate tools, drilling machines, cable bits, wired TLJBs cable termination boxes and cable cut detection equipment etc. In case, there is more than one location of deep screening of Turnout in a division, the staff strength needs to be increased accordingly.

v. If any cable laying is required and feasible, the same shall be done at an adequate depth across the affected track portion with engineering co-operation duly indicating the same in cable layout diagram.

4.17.2. Associated works of TRD department

i) SSE/JE (TRD) is to inspect the site one day in advance and assess the quantity of work such as disconnection of polarity bonds, L-bonds, structure bonds, cross bonds and insulation sleeves. Adequate insulation sleeves and rail jumpers for arranging temporary connection are to be arranged well in advance. If the Engineering work involves disturbance in OHE height and setting distance of OHE mast, tower wagon should be arranged for checking and adjusting the OHE alignment before cancelling the traffic block. The power block should be included in the program.

■ ■ ■

CHAPTER 5

RECONDITIONING OF POINT AND CROSSING COMPONENTS

5.0 Introduction: Wear and tear of point and crossing components is much more frequent than rest of the track because of continuous hammering and heavy flange forces in the switch as well as crossing area. Impact forces are further augmented because of wear of turnout components if not attended promptly. Such a heavy impact loading causes over stressing and subsequently failure of point and crossing components. Hence it is very important to periodically recondition point and crossing articles to achieve optimum life of switch and crossing components.

With the improvements in reconditioning technology now one round of reconditioning may last for more traffic. In the field, it has been experienced that by multiple reconditioning the life of crossing can be increased by 100-200% as compared to the life that can be achieved without any reconditioning. As per Railway Board letter no. Track/21/2007/0401/7/CMS Xing, number of reconditioning of CMS crossing have been limited to 3 subject to its structural condition. Since the cost of points and crossing article is very high and replacement is a cumbersome process, we need to increase the life of points and crossing articles by re-conditioning. Since chemical composition of built up article (made out of rail by machining) and the CMS crossing is quite different, different methodology is to be followed for built up as well as CMS crossing.
Differences in the properties of built up and CMS crossings is shown in Table 5.1.

5.1 Selection of various point and crossing components for reconditioning:

a) Condition of component: Component to be reconditioned should be in good condition and certified by sectional JE / P Way for

Table 5.1

a) Chemical composition:

Elements	**Medium Manganese (Gr-710 or 72 UTS)***	**Wear resistant (Gr-880 or 90 UTS)**	**High Manganese or Cast Manganese Steel (Hadfield Steel)**
C %	0.50-0.60	0.60-0.80	1.0-1.4
Mn %	0.95-1.25	0.80-1.30	11.0-14.0
Si %	0.05-0.30	0.10-0.50	$ 0.50-Max
S %	0.06-Max	0.05-Max	$ 0.03-Max
P %	0.06-Max	0.05-Max	$ 0.06-Max.

b) Mechanical properties:

Elements	**Medium Manganese (Gr-710 or 72 UTS)***	**Wear resistant (Gr-880 or 90 UTS)**	**High Manganese or Cast Manganese Steel (Hadfield Steel)**
UTS	72 Kg/ mm^2 minimum	90 Kg/mm^2 minimum	Not specified
Elongation	14% minimum	10% minimum	Not specified
Hardness	220 BHN	260 BHN	@229 BHN

** Now generally not used in manufacture of Points & Crossings as per correction slip no.2 of April'94-IRS-Specification-T-29/74.*
@ This is initial hardness value which increases to about 450 BHN gradually with work hardening of the running surface under passage of traffic.
$ Heat-treated/welded crossings will have same chemical composition as that of 90 UTS rails. Their surface hardness will, however, be in the range of 330-340 BHN.

suitability for reconditioning and should normally not have exceeded specified limit of wear. Points and crossings containing cracks on worn out portion having depth more than 3 mm (as determined by gouging) beyond the condemning size should not be selected for further reconditioning. Ultrasonic testing should also be carried out as specified. Point and crossing having internal defects should not be reconditioned.

b) Wear limit: Wear on wing rail and nose of crossing should not exceed 10mm. However, on Rajdhani/Shatabdi route as a good maintenance practice crossing and wing rail should be planned for reconditioning before reaching wear limits given below:

Built up crossing - 6mm
CMS crossing - 8mm

5.2 Resurfacing technique: Single electrode technique as well as flux cored continuous wire welding process are approved techniques for resurfacing. Normally single electrode technique is followed in field at most of the places.

5.2.1 Depot resurfacing: Point and Crossing components can be reconditioned in depot. For depot reconditioning Points and Crossing components are required to be removed from the track by replacing it with the good component. It is then transported to the reconditioning depot, where better quality can be expected as it is executed in controlled environment.

5.2.2 In-situ resurfacing: In this method, reconditioning of point and crossing components are done in track itself after taking block or by imposing caution order following the conventional arc welding technique. Robotic welding technique shall be used for in-situ reconditioning of CMS crossing on all routes having traffic density more than 30GMT. On routes having traffic density upto to 30GMT and loop lines of all routes decision regarding type of electrode and technique to be used shall be taken by CTE keeping in view the local requirements and other relevant factors so that track maintenance does not suffer.

5.3 Welding electrodes: Only H3 series of electrodes are approved by RDSO for reconditioning of points and crossing. List of approved sources for supply of electrodes is issued by RDSO periodically. Current list of approved sources of electrodes may be obtained from website of RDSO. Different electrodes are expected to provide different traffic carrying capacity. Following traffic carrying capacity have been stipulated-

a) H3 class to achieve minimum service life of 15GMT.

b) H3A class to achieve minimum service life of 25GMT.

c) H3B class to achieve minimum service life of 35GMT.

d) H3C class to achieve minimum service life of 50GMT.

5.4 List of equipments required for reconditioning

5.4.1 For crossing and switches fabricated from 72 UTS or 90 UTS rails: Equipment required for (flux shielded) metal arc welding are listed below:

i) A portable welding generator DC set or AC set with 80 OCV or more

ii) Welding cables

iii) Electrode holder

iv) Ground clamp

v) Welding electrodes

vi) Pre-heating oven for electrodes

vii) Pre-heating arrangement for crossing body (torch)

viii) Gouging equipment

ix) Chipping hammer, wire brush etc.

x) Protective clothing including hand gloves, apron, shoes etc.

xi) Welding hand shield

xii) Magnaflux kit

xiii) Dye penetration testing kit

xiv) Tong testing

xv) Thermochalks

xvi) Grinders/Hand grinding Machine (preferably electric angle grinder or straight grinder)

xvii) Templates for finishing switches, crossings and SEJs after resurfacing by welding

xviii) Hammer ballpeen ½ kg. weight

xix) Wire feeder in case of flux cored continuous wire welding process

5.4.2 For CMS crossings :

i) All equipments mentioned above except pre-heating arrangement for crossing body at SL No. (vii)

ii) A water tank made of either masonry or steel plate walls of suitable size which can accommodate a crossing

5.5 Process of reconditioning in depot

a) Surface preparation: The location to be reconditioned shall be ground by pneumatic or electric grinder to remove adherent scales, deformed and work hardened metal and surface cracks. Any surface crack should be removed by grinding. After grinding the location to be welded shall be tested by the magna flux or dye penetrant method to ensure freedom from cracks. In case of CMS crossings, magnaflux method cannot be used.

b) Precautions in use of Electrodes: The packing of electrode should be absolutely intact and all electrodes are consumed within 6 hours after opening of packing, otherwise the electrodes should be dried in the electrical over at 130-170^{0}C for at-least 1 hour immediately before use. Care should be taken to use shortest possible arc and minimum weaving. Only 4 mm electrode should be used. Electrodes having cracked and damaged flux covering shall be discarded. Electrode should be stored in a dry store room.

c) Welding sequence: In case of reconditioning of switch, stock rail should be reconditioned before tongue rail. Afterwards the worn out tongue rail shall be reconditioned in the closed position i.e. resting against the stock rail. In case of broken toe, the tongue rail is to be built up initially and hammer forged in the open position and thereafter tongue rail shall be closed with stock to obtain the final profile.

In case of crossing, runs should be deposited in turn on the right wing rail, nose and left wing rail as shown in figure no. 5.1.

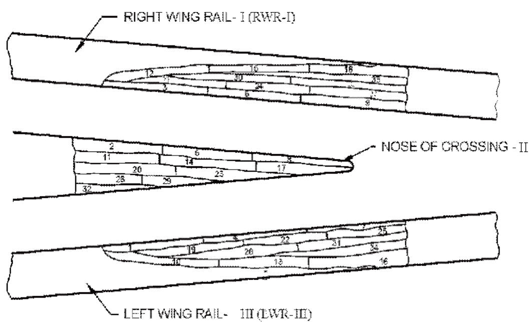


Fig. 5.1 Welding sequence

d) Welding plant and accessory: All electrical appliances should be earth properly. Tongue tester should be available with the welding plant to check the actual output of welding current. Current range as recommended by manufacturer for particular brand selected for welding shall be used. In case of CMS crossing, DC generator with reversed polarity is preferred.

e) Preheating: Pre heating is required for reconditioning of tongue rail and for reconditioning nose and wing rails of built up crossings only. The component should be pre-heated by oxy-acetylene flame to a temperature between 250-300^{0}C before welding. This temperature should be maintained throughout welding operation. In case of interruption, same temperature should be ensured before restarting of welding. Temperature can be measured by contact type pyrometer or tempil stick (thermo chalk) or by laser thermometer. No heat treatment is required after welding. In case of CMS crossing no pre heating is required.

f) Current condition: Current range as recommended by manufacturer of particular brand of electrode selected for welding shall be used. In case of CMS crossing, welding is carried out with reversed polarity to minimize vibration or as recommended by electrode manufacturer. Current at the lower side of range recommended by electrode manufacturer should be used to reduce the heat input in the base metal to reduce dilution of base metal which would otherwise cause embrittlement in the weld.

g) Welder: Only skilled welders who have been trained and certified by competent authority in resurfacing of points and crossing in arc welding can only be engaged. Welders should be checked and certified by Chemist and Metallurgist of the Railway or by any other officer nominated by Chief Engineer of concerned railway in case of departmental welder and by RDSO in case of private welder or outside welder. RDSO can also authorise training centres of welding electrode manufacturing firm to train contractor's welder. Competency certificate will be valid for 5 years.

h) Welding operation: Welding should be done in flat position following the welding sequence as mentioned in fig. 5.1. The arc shall be struck on the points/crossing and then the electrodes shall be progressively advanced by maintaining the arc using uniform movement. Care shall be taken to fill the crater to the full weld size before breaking the arc to avoid formation of crater cracks. During the re-start of the welding operation, the arc shall be struck ahead of the crater and then drawn back. Slag shall be removed thoroughly in between runs. Depending on the depth of wear, the number of layers to be deposited shall be assessed and sufficient weld metal shall be deposited to provide an excess of weld metal by about 3 mm which shall be finally finished by grinding. An interpass temperature of 250^0C to 300^0C shall be maintained throughout during the welding of switch and built up crossing. Slag inclusion shall be removed by suitable hardwire brush having 3 rows of bristles and suitably hardened chipping hammer having pointed ends. After completion of welding, reclaimed area carefully checked for defects. Undercut, groove or any other defect shall be removed immediately by electrode cutting followed by re-welding

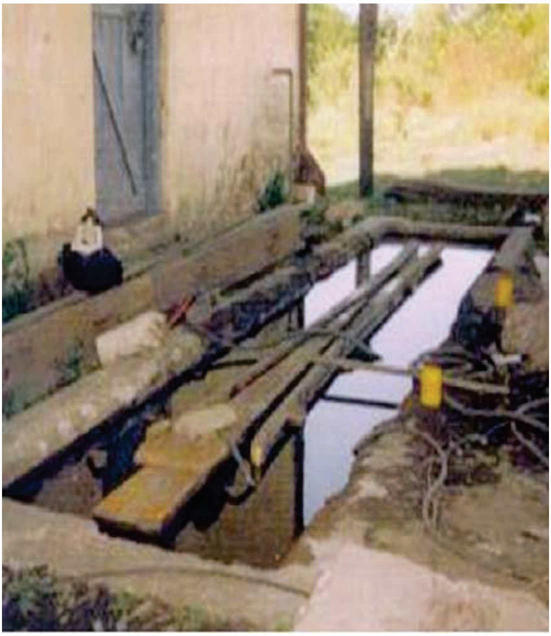


Fig. 5.2 Reconditioning of CMS crossing

In case of **CMS crossing** welding cycle should be short i.e. not more than 2 minutes at a time and on no occasion more than one run shall be deposited. Sequence of welding as given in fig. 5.1 should be followed in such a way that the temperature of adjoining area remains below 150^0C by means of compressed air jet or water quenching. Alternatively crossing may be kept submerged in water bath in such a way that only top 1cm remains projected above water (fig. 5.2). No heat treatment is required after welding.

Normally during welding weaving should be reduced to bare minimum, how ever, in case of CMS crossing at a time a run of 7-8cms length only shall be deposited by using weaving technology with the electrode kept at 45^0 angle to the direction of welding. The width of welding in case of CMS crossing should be double of diameter of electrode.

i) Grinding: Reconditioned surface is finished properly by grinding operation. Templates as per Appendix-XVI of "Manual for reconditioning of medium Manganese (MM) steel points and crossings, switch expansion joints and cast manganese steel crossings" should be followed. A straight edge along with proper template should be used to check the profile after grinding. During grinding water should be sprinkled regularly and grinding wheel shall be moved back and forth over the area and not stop at one point to avoid high localised heating and cooling.

5.6 Special provisions for in-situ reconditioning of medium manganese steel or 90 UTS points and crossing componenets:

Normally similar steps are required to be taken for in-situ reconditioning of medium manganese steel or 90 UTS points and crossing. Operations like surface preparation, preheating, welding, qualification of welders and sequence of welding is same. However trains can be passed at full speed over the weld metal on crossing even before completion of hard facing operation. But the weld metal should be allowed to cool for 2-3 minutes before allowing train to pass over it. After passage of train, welding can be restarted again.

In case of welding of tongue/stock rail passage of train is not advisable before actually finishing the grinding operation. There have been instances where train allowed to travel on unfinished tongue rail got derailed because of obstruction created by thick metal at ATS. So in case of in situ reconditioning of switch, stock rails should be reconditioned before allowing any train operation. Reconditioning of one tongue rail should be taken up at once and it's reconditioning should be finished while the train may be moved on other tongue rail. Same process can be repeated while reconditioning other tongue rail.

5.7 In situ reconditioning of CMS crossing by Translamatic Robotic Welding Technology: For reconditioning of any component of point and crossing in depot, replacement of the component from track for reconditioning requires huge amount of manpower and traffic block. Transportation of switch and crossing components is also difficult because of heavy weight and awkward shape. All these resources can be saved if reconditioning of CMS crossing could be done in situ. As metallurgy of CMS crossing does not allow easy conduction of heat, in situ reconditioning by regular method is not allowed. It can only be done by special process, in which generation of heat is controlled. In case of overheating at any location micro cracks may develop that may propagate under impact loading leading to failure of CMS crossing. Now special method have been evolved which can be used for in situ reconditioning. This method has been given name Translamatic Robotic Welding. Initially this procedure was adopted for trial, now it has been approved for regular adoption, and "model standard tender conditions" have been circulated for adoption while calling for tender.

Fig. 5.3 Translamatic Robotic welding

Such equipment is provided with special robotic arrangement through which reconditioning of CMS crossing can be done from small arcs and the temperature is controlled. In this method special core fluxed filler wire electrodes of 1.6mm diameter are used. Welding current between 170-190Amps DC is used at the voltage range of 26-28V and positive polarity is used. No pre-heating is done and temperature before laying every bead should not be more than 100^{0}C. The hardness achieved immediately after welding is of the order of 200-240 BHN and after hammer hardening it is raised to range of 450-500 BHN. The in-situ reconditioning of CMS Crossing by Translamatic Robotic Welder is either performed first time i.e. on original Cast Manganese Steel or already reconditioned crossing with the same process. Normally a speed restriction of 20-30kmph is imposed while doing in-situ reconditioning for each CMS crossing by Translamatic Robotic Welder.

5.8 Steps of Translamatic Robotic Welding: Following steps are followed for reconditioning by Translamatic Robotic Welding:

1. Grinding of the defective area by Profile, surface and angle grinder to obtain the base metal with proper slope on both sides of defects.
2. Checking defect area by DPT.
3. Mapping the area to be welded in both nose & wing portion of the crossing.
4. Setting the Translamatic Robotic welding machine on the crossing.
5. Set the electrode wire feed rate & traversing speed as constant.
6. Select proper voltage on DC generator.
7. Start the sequential welding from left wing portion then to nose & then to right wing portion, and again coming back to left wing portion and so on ….
8. Monitor the temperature.
9. Set the stick out of welding gun on each bead.
10. The welding torch traverses as per the parameter set into its memory depositing weld metal at the specified location.

During surface preparation, it is desirable to reach up to parent & sound layer. In surface preparation, the portion to be reclaimed shall be ground by hydraulic grinders to remove all work hardened metal, cracks, adherent scale etc. It shall be ensured that before welding, all surface cracks have been removed, as any left over crack on the surface may extend due to contraction of the weld deposit during cooling and cause premature failure of the CMS crossing in service. The care shall be taken that no localized grinding shall be done to avoid the excess heat generation. After grinding, the locations to be welded shall be tested by Dye Penetrating method to ensure freedom from cracks.

During resurfacing by Translamatic Robotic Welder the Austenitic Manganese Steel Crossing requires great care in reducing the heat input. Not more than one run shall be deposited. The Translamatic Robotic Welder is programmed in such a manner to follow skip welding sequence or to weld different portion of the crossing by rotation. This rotation will also help to ensure that the temperature of the adjoining areas remains below 100 degree centigrade before starting new run.
After completion of welding, the reconditioned area shall be finished by grinding to obtain a smooth surface. The sharp edges along the flange-way shall be ground to proper radius and profile with the help of templates, so as to match with the original contour of the rail. The grinding wheel shall be moved back and forth over the whole area and not stopped at one point so as to avoid high localized heating and cooling which may initiate grinding cracks. The ends of the welding at rail table shall be matched with the original top plain of the crossing with a maximum possible slope.

5.9 Testing and inspection of reconditioned points and crossings: Resurfaced points and crossing after cooling and finished shall be subjected to visual inspection, dimensional measurement and freedom from surface defects such as under cut, weld inclusion, porosity, cracks etc. The points and crossing found to be free from surface defect shall be subjected to magna flux or dye penetration test to check for other surface cracks which cannot be detected by visual examination. CMS crossings cannot be inspected by magna flux; it can only be checked by dye penetration test. The details of dye penetration test can be seen in Appendix-II of "Manual for reconditioning of medium Manganese (MM) steel points and crossings, switch expansion joints and cast manganese steel crossings".

5.10 Rectification of defects after testing: If any defects are found by the test indicated above, the defective portion shall be removed either by pneumatic gouging or grinding and the remaining portion shall be re-examined by dye penetration test before undertaking further repair. If the DPT test indicate presence of any crack the portion shall be rewelded, ground, and again inspected to ensure freedom from defects.

Fig. 5.4 Dye penetration test

5.11 Record of point and crossing: Before start of welding, the history of switch and crossing should be collected and recorded on register. The record should show the station, point number, up or down line, facing/trailing direction, traffic density, angle of crossing, UTS, date of various resurfacing carried out and the traffic carried after every reconditioning along with reading of wear on left wing rail, nose and right wing rail, brand and size of electrode used, quantity of electrode used, grinding time and name of welder. Wear of reconditioned crossing is required to be measured every quarterly. Wear should be measured on 4 locations on wing rails, and 2 locations on V rail (nose) as given in the fig. 5.5.

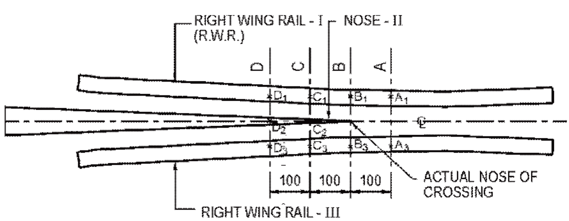


Fig. 5.5 Location for recording wear of crossing

In case of tongue rail wear is to be measured at seven locations starting from one of the toe to the places at every 100mm towards heel.

5.12 Do's and Don'ts of welding process:

5.12.1 Do's

a) Clean worn out area thoroughly to ensure freedom from dust, rust, grease or any foreign material.

b) Ensure freedom from cracks or any other defect by visual inspection followed by magnetic particle or dye-penetrant test.

c) Use DC generator/rectifier with rating of 65-80 OCV (Open Circuit Voltage). It should preferably be with reversed polarity in case of CMS crossings.

d) The cables should be free from any damage.

e) The cables should not be too long to avoid current loss.

f) The power source and job to be welded should be properly earthed.

g) Use only RDSO approved electrode of H3 series. Viz. H3, H3A, H3B and H3C (as per the current list of approved sources by RDSO).

h) Use 4mm dia electrode.

i) Current to be as specified by manufacturer.

j) Use short arc length.

k) Employ short stringer beads.

l) Weld with job in flat position.

m) Adopt skip welding sequence in the order LWR, NOSE & RWR or vice-versa.

n) Preheat MMS or 90 UTS switch/crossing/SEJ to 250 degree centigrade, but no preheating of CMS crossing to be done.

o) Maintain inter-pass temperature less than 150 degree centigrade for CMS crossings and at about 250-300 degree centigrade for MMS or 90 UTS crossings/switches/SEJs.

p) Welding cycle to be of not more than 2 minutes.

q) Maintain electrode angle at 45 degree with the direction of welding.

r) Deposit, run of short length i.e. 7 to 8 cm. at a time for CMS crossings.

s) Remove the slag completely before restart of welding.

t) Grinding for surface preparation/finishing to be done avoiding localized heating.

u) Dry electrodes for about one hour in the over at a temperature of 130 to 170 degree celcius before use.

v) During the process of welding, entire CMS crossing to be kept submerge in a water trough except for its head portion projecting out of water by 10mm to ensure that its temperature does not increase (It is not applicable to MM Steel points and crossings).

5.12.2 Don'ts:

a) Welding of rusted, greased or cracked surface/location.

b) Test with magnetic particle tester in case of CMS crossing.

c) Welding with lower OCV than specified 65-80 OCV.

d) Use damaged cables for welding.

e) Use too long cable for welding.

f) Do welding without proper earthing.

g) Make use of electrode brands not having RDSO approval.

h) Use higher diameter of electrode unless specified.

i) Use very high currents. (Higher current can be used in case of continuous wire welding process).

j) Use larger arc lengths.

k) Have higher non-stringer beads.

l) Do welding in vertical down position.

m) Do welding continuously

n) Pre-heat the CMS crossings

o) Have welding cycle of more than 2 minute for welding CMS crossings

p) Have electrode angle more than or less than 45 degree with the direction of welding.

q) Do welding without completely cleaning the slag.

r) Do welding on CMS crossings without quenching facilities.

s) Grind for longer period at the same location.

5.13 List of appendix: Following are the appendix of Manual for Recoditioning of Medium Manganese (MM) steel points & crossings, switch expansion joints (SEJ's) and Cast Manganese Steel (CMS) Crossings:

APPENDIX 1.	Magnetic particle testing
APPENDIX 2.	Dye-penetrant testing
APPENDIX 3.	Approved list of manufacturers of consumables used in DPT/ MPT
APPENDIX 4.	Checklist for resurfacing of wornout MMS switches, Built up crossings, SEJs and CMS crossings.
APPENDIX 5.	Common faults in metal arc welding
APPENDIX 6.	Do's and Don'ts of welding process
APPENDIX 7.	Code of procedure for ultrasonic testing of worn out crossings prior to reconditioning by welding using ultrasonic testing trolley/pocket rail tester.
APPENDIX 8.	Technical specification for battery operated Pulse Echo Type Digital Pocket Ultrasonic Rail Tester (Tentative)

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CHAPTER 6

LAYING OF FAN SHAPED LAYOUT ON CURVE

6.0 Fanshaped turnout: The original designs of point and crossing were issued by RDSO vide drawing numbers RDSO/T-4865 (1 in 8.5, 52/60kg), RDSO/T-4218 (1 in 12, 60kg) and RDSO/T–4732 (1 in 12, 52kg). In these drawings, inter-sleeper spacing have been given for all the sleepers. The inter sleeper spacing have been calculated with presumption that main line is a straight track. Sleepers have been placed in 3 different patterns in 3 different areas of turnout-

Type of layout	Switch Area : Sleepers under switch laid perpendicular to main line	Lead Area : Sleepers laid at an angle θ/2, θ is angle between normal to tangent drawn at any point on turnout outer rail and normal to main line corresponding to this point on main line	Crossing Area : Sleepers laid perpendicular to bisector of crossing angle
1 in 12	1 to 20	21 to 65	66 to 83
1 in 8.5	1 to 13	14 to 42	43 to 54

It may be noted that the switch, lead and crossing areas as defined above may not match with the usual definition of switch, lead and crossing. On comparison of orientation of sleeper in switch and crossing area, it is seen that it is similar to IRS layouts. But sleeper orientation is different in the lead area. In case of fan shaped turnouts, sleepers in lead area are oriented along the direction of bisector to the perpendiculars drawn to main line and turnout side (Fig. 6.1). In order to achieve this kind of orientation necessary differential spacing on outer and inner side have been indicated in the drawing. Spacing between sleepers has been kept more on outer side and less on inner side. As the sleepers in the lead area are oriented in radial direction, these layouts are called “Fan Shaped Layout”.

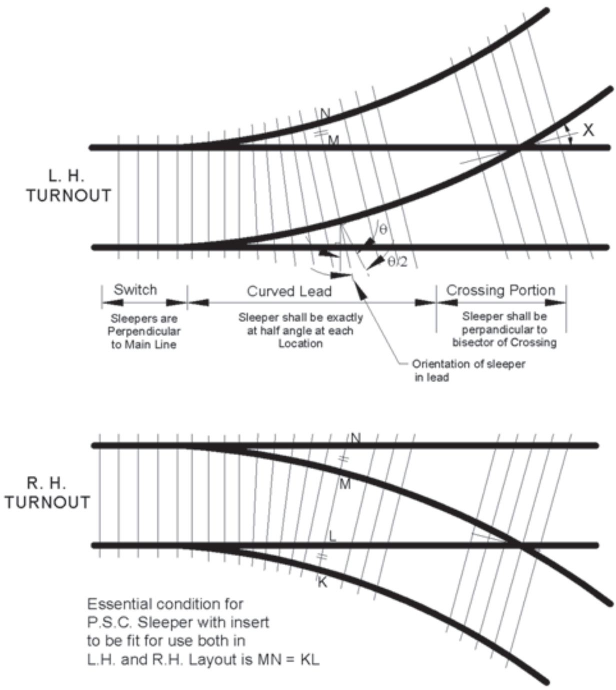


Fig. 6.1 Laying of sleepers in Fan shaped Turnout

Spacing of sleepers in lead area has been calculated based on the above quoted principle with main line as straight track. But, when the turnout is laid on curved track, spacing as given in the drawings (suitable for straight main line) are not suitable. One can recall that while laying plain track sleepers on curve, the sleepers are to be laid perpendicular to the rail i.e. radially to track. The spacing of the sleeper on inner rail is required to be reduced to lay sleepers perpendicular to the rail. The spacing of the sleepers for laying fan shaped layout on curved main line needs certain modification for the similar reasons. If we do not follow the correct sleeper spacing as required for main line curve it becomes impossible to provide liners in the crossing portion. It is the tendency of field staff to shift the sleepers in such a way that liners are somehow fixed. But In such cases many problems are encountered which leads to deterioration of the track. Following are the problems felt while laying the fan shaped layout on the curve: -

a) The distance between insert and the rail does not remain uniform as the rail does not remain parallel to the insert. In this situation, it may not be possible to insert liner especially near the crossing. Since most of the turnouts fall in the track circuited zone, we need to provide GFN liners. Because of the undue stresses coming while pushing the liner at such locations, GFN liners may break. Such breakage of liners may lead to short circuiting in the track circuits if sleeper's insulation is not enough.

Fig. 6.2 Showing large gap at insert

b) Because of non uniform gap between the rail and insert, it is not possible to maintain correct gauge on the turnouts.

c) Sometimes because of inadequate space, liners cannot be inserted on one side, at the same time it may lead to excessive gap on the other side. In case of very high gap, toe load is affected and it is found to be much lesser than the desirable. In case of excessive gap between rail and insert, toe load is applied by ERC on GFN liner on the unsupported area, which may cause breakage of GFN liners.

d) It is simply not possible to insert liners on the crossing portion because of less space; hence the holding of CMS crossing is improper which affects gauge and alignment badly. At many places thin seat of CMS crossing where ERC is supposed to be fixed, does not come over sleeper, so ERC may not be fixed.

e) At few place because of factors described above, rail foot may rub against insert. It has been observed at few places that rail have made a groove in the inserts because of continuous rubbing against it.

A big percentage of turnouts have been laid on the curve on Indian Railways because of yard on curved alignment and it may not be possible to shift such turnout on straight. So laying of PSC layout on curve is unavoidable. Therefore, there is a need to improve laying of turnouts on the curve to avoid above quoted problems. It has been observed such problems are more pronounced in case of turnout laid on curve sharper than 1^0. Hence there is a need to modify the laying of turnouts on sharper curve to suit as per the curvature in the track. The required adjustment can be achieved by modifying spacing of the sleepers. Such modifications are different for similar flexure/contra flexure turnouts, for different angle of turnout and for different degree of curves on which it has been laid. The modifications have been explained in following paragraphs.

6.1 Pattern of laying sleepers: As sleepers on the turnout are laid in 3 different patterns in 3 different areas of a turnout, modification in the pattern have to be different in all the 3 areas.

a) In the switch area which extends from sleeper No. 1 to 20 in 1 in 12 turnouts and from sleeper no. 1 to 13 in 1 in 8.5 turnouts, sleepers are laid perpendicular to the main line. Ordinary switches are provided with the holes in the factory itself for fastening it with slide chairs. Re-drilling of holes is not possible in field, hence while laying switch in curved main line it is not possible to modify spacing of sleepers in this area for ordinary switches. However modification of sleeper in switch area, in case of thick web switch and for ordinary switch if holes in stock rails are drilled as per revised spacing, is possible as explained in para 6.2 (c)

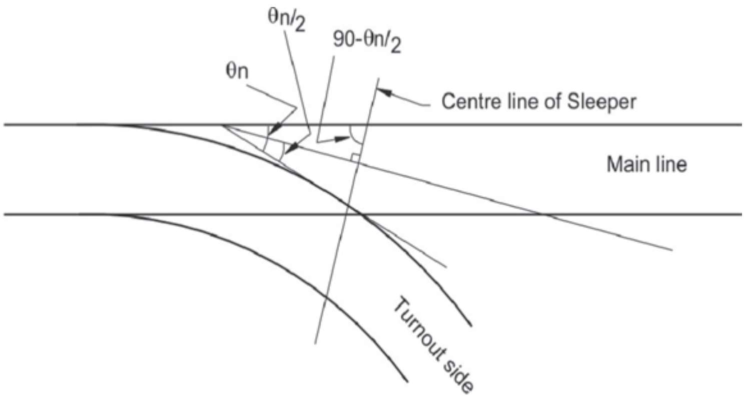


Fig. 6.3 Turn out laid on straight

b) In the lead portion, which extends from sleeper no. 21 to 65 on 1 in 12 turnouts and from sleeper no. 14 to 42 on 1 in 8.5 turnouts, sleepers are laid along the direction of bisector of perpendiculars drawn to the main line and to the turnout side. Hence in this area, the direction of sleeper will be perpendicular to the bisector of the angle made by tangents drawn to main line and turnout side (Fig. 6.3). It is seen that the sleeper axis makes an angle of $(90-\theta_n/2)$ from the straight track (or the tangent drawn at SRJ).

However, while laying the same turnout on the curve, the tangent drawn to the main line is also changing direction along with the location. Suppose the tangent drawn to the main line of turnout at the location of sleeper makes an angle of θ_m with the tangent drawn to the SRJ (fig. 6.4), in order to maintain sleeper perpendicular to the bisector of the angle made by tangents drawn to main line and turnout side, the sleepers will also be required to be further rotated by an angle

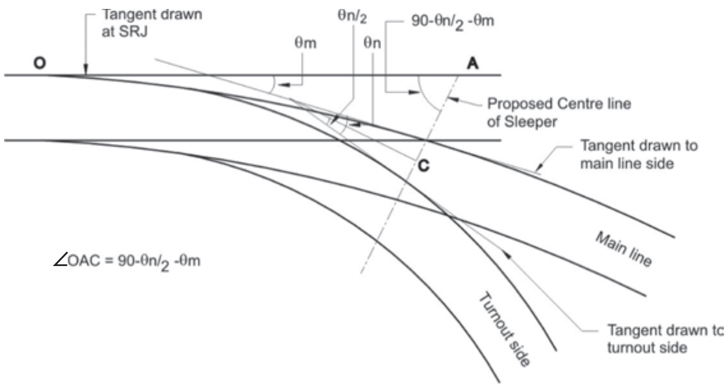


Fig. 6.4 Turnout laid on curve

equal to the θ_m (fig. 6.4) since it makes an angle of $(90-\theta_n/2-\theta_m)$ with the tangent drawn to SRJ. This additional rotation will reflect into change in the spacing of all the sleepers on the lead portion. Such changes will depend on the type of turnout, degree of main line curve and whether the turnout is similar flexure or contrary flexure.

Since ERC can be fixed on CMS crossing at certain pre-decided locations it is better that the spacing is not changed on the rail of mainline on which crossing is likely to come i.e. the side on which train negotiates tongue rail while going towards main line. Hence the spacing of sleeper 21 to 65 is changed on the side on which crossing is not coming.

As we have seen earlier that change in spacing is also required between sleeper No. 1 to 20 by the same principle but since holes in the stock rails in case of ordinary switches are received drilled from the factory, spacing on the switch area cannot be changed but the total difference of spacing accrued between sleeper No. 1 to 20 is required to be adjusted between sleeper No. 20-21 on 1 in 12 turnout and between sleeper no. 13-14 in 1 in 8.5 turnout.

c) In the crossing area sleepers are laid perpendicular to the bisector to the crossing legs. Same principle is applied while laying the turnout on the curve. Hence the sleepers are also required to be oriented along the direction perpendicular to the bisector of the crossing.

6.2 (a) Table for sleeper spacing for ordinary switch turnout taking off from curve : For laying of 1 in 12 fan shaped turnout on the curved track as similar flexure, a table was circulated by RDSO vide their letter no. CT/PTX dated. 17.8.07. The sleeper spacings have been recalculated using first principal and the tables are given for ready reference as Annexure 4 and 5 respectively. On the similar analogy a table has been made for 1 in 8.5 turnouts laid on contrary flexure. This is also given for ready reference as Annexure 8 & 9. These annexures are not issued by RDSO. Hence before its use necessary consultation may be made with concerned authorities.
In these annexure spacing of sleepers have not been changed

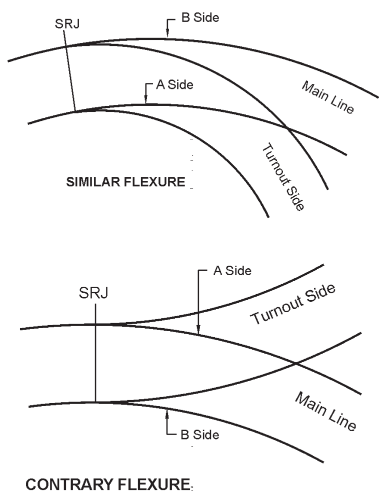


Fig. 6.5

on side A i.e. side where crossing lies, for any curvature of main line track, but the spacing have been changed on other side i.e. side B. It is pointed out that fig. 6.5 may be referred for using the annexure 4 to 9. In this sketch the side to be considered as A or B has been explained.

6.2 (b) For Thick web switch: In case of thick web switches, since stock rail is fixed to sleeper by arrangement of ERC, the spacing in switch portion can also be altered suiting to main line curvature. Hence sleeper spacing in case of thick web switch shall be arranged based on degree of curve of main line as explained in 6.2 (c). As it may not be possible to have PSC sleepers spacing changes for each and every degree of main line curve, it is suggested that pre-curving & modified sleeper spacing as per grouping shown in Table 6.1 be followed by zonal railways for laying of turnouts with thick-web switches on curved track. The sleeper spacings for 1 in 12 thick web switch turnout have been given in annexure 6 & 7 for similar and contrary flexure respectively.

Table 6.1

PSC Sleeper spacing for mainline curve of following degree (as per RDSO's letter no.CT/PTX dated 17.08.2007 & 07.10.2005 for similar and contrary flexure turnouts respectively)	Degree of Mainline Curve	
	In Contrary Flexure	In Similar Flexure
Straight	up to 0.5^0	up to 0.5^0
1^0	$>0.5^0$ & up to1.5^0	$>0.5^0$ & up to 1.0^0
2^0	$>1.5^0$ & up to 2.0^0	-

6.2 (c) Explanatory note regarding calculation of sleeper spacing for Annexure 4 to 9 for laying of PSC fan shaped layout ordinary or Thick web switch taking off from curve:

When turnout takes off from curved main line the main line portion of entire turnout region should take the same shape as that of the main line curve to keep the negotiability of train through the main line curve as smooth as possible. Since crossing is a straight component it is not possible to ensure curvature in that region however with use of curved crossing or movable crossing this aspect can be taken care. For the purpose of explanation 1 in 12 turn out has been taken. The same concept will apply to 1 in 8.5 turn out for calculation of sleeper spacing for the entire turnout.

(1) Sleeper spacing in switch portion : Since in ordinary overriding switches the holes in stock rails are at prefixed spacing as of now the spacing can not be changed and has to be as per RDSO drawing only. However if Railway decides to improve the running of trains in switch portion also by asking the manufacturer to drill the holes in stock rail as per revised sleeper spacing in switch portion then the same spacing as being given here for thick web switch can be maintained, which will be the spacing suiting to the degree of main line curve. Only one side of stock rail needs to be made with revised hole spacing as per following calculation corresponding to particular sleeper.

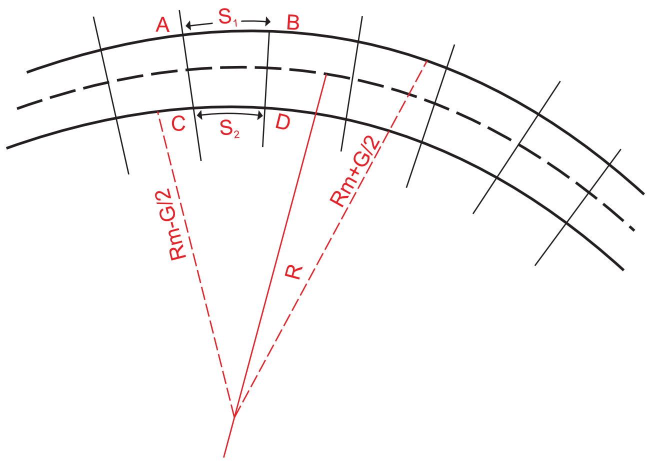


Fig. 6.6

If we consider above situation of main line curve and if spacing on AB i.e outer side is 'S_1' and on CD i.e. inner side it is 'S_2' then S_1 and S_2 are related as under;

$$S_1 = S_2 * (Rm+G/2)/(Rm-G/2) \text{ ----------- } (6.1)$$

where Rm is radius of main line in mm, and G is Gauge and S_1 and S_2 are measured along gauge face line of both the rails in mm. Hence if one side dimension is given the other side dimension can be calculated. Here the given dimension should be taken the one on which crossing lies. This will apply upto 20^{th}

sleeper in case of 1 in 12 and 13th sleeper in case of 1in 8.5 turnout. By doing so the main line part of switch area will have the same shape as that of main line curvature.

(2) Sleeper spacing in lead portion:

(A) Turnout taking off from straight : To better understand the concept let us first try to understand how the sleeper spacing at 21st sleeper is calculated in case of turnout taking off from straight.

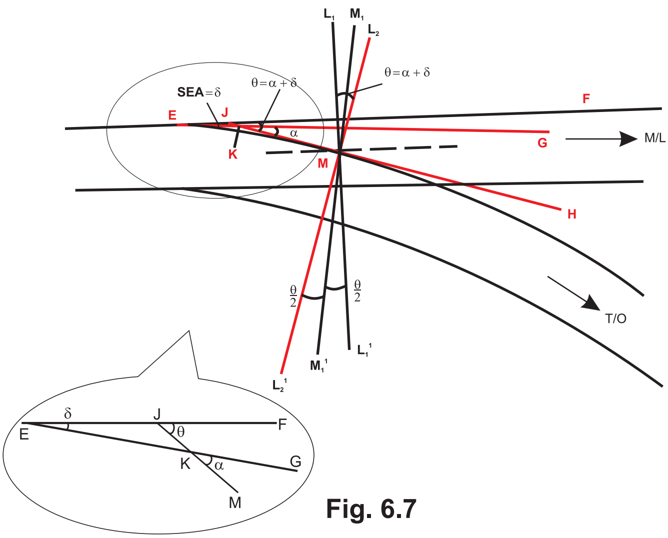


Fig. 6.7

In fig. 6.7, EG shown in red, is tangent drawn at ATS on tongue rail gauge line.

FEG = Switch entry angle = δ

JKH is tangent at any point M on turnout outer lead curve which makes an angle α with tangent EG, Hence angle GKH = α

Angle between tangent JH and straight main line EF or gauge line of stock rail of main line is denoted as θ.

In Δ EJK , (see abstract sketch) angle JEK = δ, angle EKJ = α, hence external angle FJM = θ = δ + α , if perpendiculars are drawn to tangents to main line and turnout at point M, then these are L_1L_1' and L_2L_2' and make same angle θ. The sleeper will be at an angle θ/2 from perpendicular to main line and oriented at

M_1M_1'. Now refer Fig. 6.8, here d1 is the spacing of sleeper on the side where crossing is situated and S_{21} is the spacing of sleeper on other side of main line. Sleeper orientation is shown by U_2T_2.

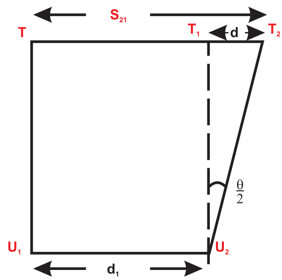


Fig. 6.8

Here, $S_{21} = TT_1 + T_1T_2$

$$= d_1 + d = d_1 + G \tan(\theta/2)$$

$$= d_1 + G \tan\frac{(\alpha + \delta)}{2} \text{ ----------------- } (6.2)$$

Here G is gauge, α is given by X/Rt/o,

Where, X is distance from ATS to the point under consideration and Rt/o is the radius of lead curve of turnout.

Exaple 1: Workout the sleeper spacing between sleeper No, 20 & 21 for 1in 12 turnout

SEA δ for 1 in 12 is 0° 20' 0" = 0.333 deg = 0.00581776 rad. G=1673 mm,

The sleeper spacing between 20th and 21st sleeper on gauge face of crossing side i. e. d_1 is 526 mm, as per RDSO drg.

X, the distance of 21st sleeper is 9986 mm(can be seen from RDSO drawing).

Hence angle α = X/R

= 9986/441360 =0.0226255 rad

= 0.0226255 x 180 / π deg.

= 1.2963 deg.

Thus, S_{21}=526 + 1.673 tan((0.333 + 1.2963)/2)

= 526 + 23.794

= 549.79 rounded off to 550 mm.

The same is given in RDSO drawing.

(B) Turnout taking off from curve on Similar Flexure: Now refer Fig. 6.9 for 1 in 12 similar flexure turnout. Here again the tangents are drawn to turnout and to main line at any point on outer lead curve. Angle θ, δ and α have the same meaning as above. Since main line is also changing its curvature at every point the angle made by tangent drawn at any point on main line on lead portion with the original tangent drawn on main line curve at ATS is denoted as θ_1. The tangents are redrawn in Fig. 6.10 to understand as how to calculate the angle θ between two tangents i.e tangent to main line and tangent to turnout at any point on lead portion so as to fix the orientation of sleeper which will be θ/2 from normal to tangent on main line at that point.

Refer fig. 6.10

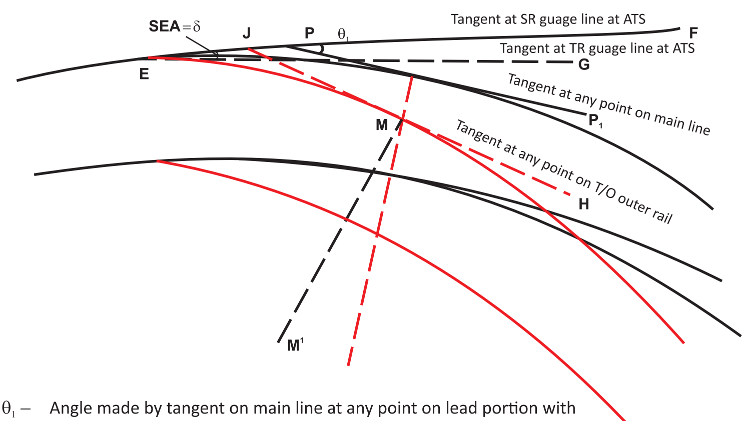
EG - Tangent drawn at ATS on gauge line of TR

EF - Tangent drawn at ATS on gauge line of SR

JM - Tangent drawn at any point M on outer line of turnout

PP1- Tangent drawn at corresponding point on main line at lead portion.

JH - Parallel to PP1 drawn at J

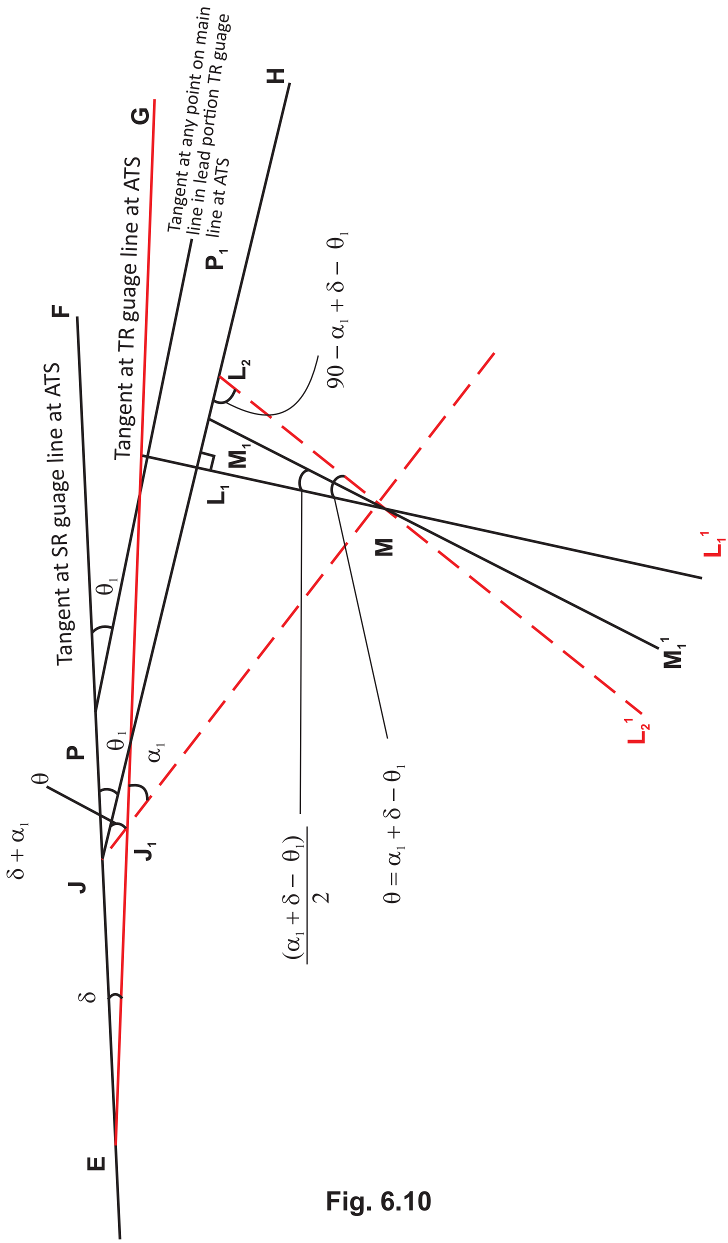


θ_1 – Angle made by tangent on main line at any point on lead portion with initial tangent on main line drawn on gauge line of stock rail at ATS.

α_1 – Angle made by tangent on outer rail at T/O with initial tangent drawn at ATS on guage line of TR.

δ – Switch Entry Angle.

Fig. 6.9



Tangent at SR guage line at ATS
Tangent at TR guage line at ATS
Tangent at any point on main line in lead portion TR guage line at ATS
F
G
H
P
P1
J
J1
E
L1
L2
M
M1
L11
L21
M11
δ
δ + α1
θ
θ1
α1
90 − α1 + δ − θ1
(α1 + δ − θ1)/2
θ = α1 + δ − θ1

Fig. 6.10

Angle FEG is δ, the angle between two tangents at ATS i.e tangents EF and EG

Angle GJ_1M is α_1, the angle between tangent JM at any point M on lead curve, with initial tangent EG at ATS on lead curve.

Angle P_1PF made between tangents PP_1 drawn at main line in lead area corresponding to point M on turnout and initial tangent EF on main line drawn at ATS, is θ1. Line JH is parallel to PP_1.

Hence $\angle FJH = \theta_1$, Consider $\Delta\ EJJ_1$ angle EJ_1J is α_1, corresponding angle. Hence angle FJJ_1 is exterior angle to EJJ_1, & is equal to $\delta + \alpha_1$.

The angle between two tangents i.e. tangent on main line curve PP_1 or JH and tangent on turnout lead curve JJ_1M at point M is $\angle HJM = \angle FJJ_1 - \angle FJH$

$\theta = \delta + \alpha_1 - \theta_1$. This is also the angle between two normal at point M. hence the sleeper orientation will be at half the angle from normal to tangent on mainline and normal to tangent on turnout lead curve at M i.e. θ/2.

Example 2 : Workout the Sleeper Spacing for 21st sleeper for 1 in 12 turnout laid in Similar Flexture:

Consider 1 in 12 turnout taking off from 1 deg main line curve in similar flexure. Sleeper is oriented at $\theta/2 = (\delta + \alpha_1 - \theta_1)/2$, where;

δ = switch entry angle = 0° 20' 0" = 0.333 deg = 0.00581776 rad.

α_1 = X/Rrl , where X is distance of point under consideration measured along main line from ATS and Rrl is resultant radius of lead curve.

θ_1 = X/ Rm, where Rm is radius of main line curve. Now refer Fig 6.11 , d_1 given spacing on the main line side where crossing is situated, = 526 mm, X at 21st sleeper is 9986 mm,

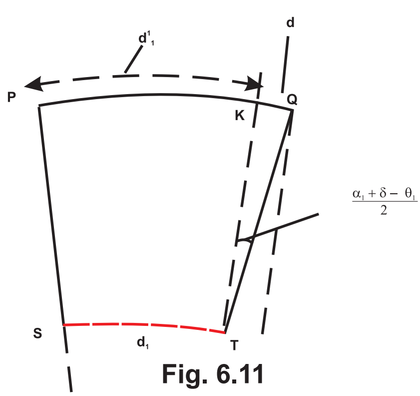


Fig. 6.11

$Rm = 1750000$ mm ,

$Rrl = 1/(1/Rm+1/Rt/o) = 1/(1/1750+1/441.36) = 352.466m$

$= 352466$ mm

$\alpha_1 = X/Rrl = 9986/352466 = 0.0283318$ rad.

$\theta_1 = X/Rm = 9986/1750000 = 0.00570628$ rad.

Sleeper spacing $S_{21} = d'_1 + d$

Where $d'_1 = d_1*(Rm + G/2)/(Rm - G/2)$

$= 526* (1750000+1673/2)/(1750000-1673/2)$

$= 526.50309$ mm

and, $d = G * (\delta + \alpha_1 - \theta_1)/2$

$= 1673*(0.00581776 + 0.0283318 - 0.00570628)/2$

$= 23.79$

Hence $d'_1 = 526.5 + 23.79 = 550.3$ mm

(b) Sleeper spacing for 22nd and onwards in lead portion:

Now refer Fig. 6.12, S_{22} i.e. TT_1 is the required sleeper spacing for 22nd sleeper. As can be seen from this figure d_2 and d'_2 are spacing of a curve on inner side and outer side respectively. Look at QKK_1T_1Q. Dotted lines are axis of 21st and 22nd sleepers.

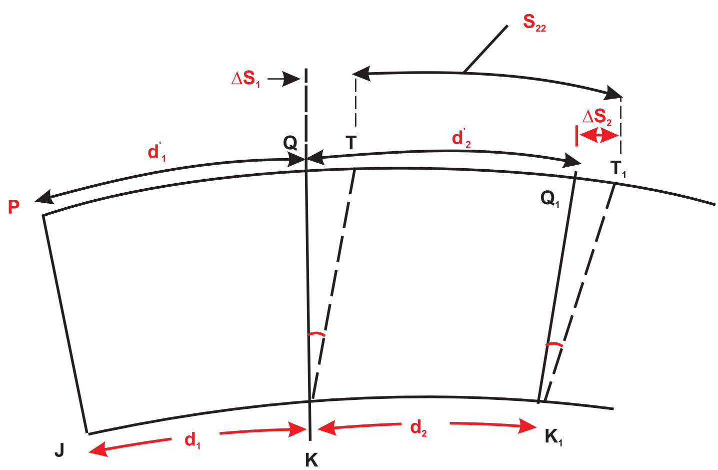


Fig. 6.12

$S_{22} = TT_1 = d_2' + \Delta S_2 - \Delta S_1$, where;

$d_2' = d_2*(Rm+G/2)/(Rm-G/2)$;

$\Delta S_2 = G*(\delta + \alpha_2 - \theta_2)/2$

$\Delta S_1 = G*(\delta + \alpha_1 - \theta_1)/2$

Hence

$S_{22} = d_2*(Rm+G/2)/(Rm-G/2) + G*(\delta + \alpha_2 - \theta_2)/2 - G*(\delta + \alpha_1 - \theta_1)/2$

Where; d_2 is sleeper spacing on the side where crossing is situated. α_2 is angle between tangent drawn on lead curve at 22nd sleeper with initial tangent drawn at ATS on lead curve. θ_2 is angle between tangent drawn on main line corresponding to 22nd sleeper and the initial tangent at ATS on main line curve. Other terms are as explained earlier.

The spacing for other sleepers i.e. 23rd to 65th in lead portion are calculated in similar way.

(C) Turnout taking off in contrary Flexure: Now refer Fig. 6.13 for 1 in 12 contrary flexure turnout. Here again the tangents are drawn to turnout and to main line at any point on lead curve. Angle θ, δ and α have the same meaning as explained earlier above. Here main line and turnout are flexing in opposite direction, the side on which crossing lies has to be taken as base line and spacing of all the sleeper shall be kept same as per RDSO drawing on this side. The spacing on other side shall be calculated based on following principles. The tangents are redrawn in Fig. 6.14 to understand as how to calculate the angle θ between two tangents i.e tangent to main line and tangent to turnout at any point on lead portion so as to fix the orientation of sleeper which will be θ/2 from normal to tangent on main line at that point.

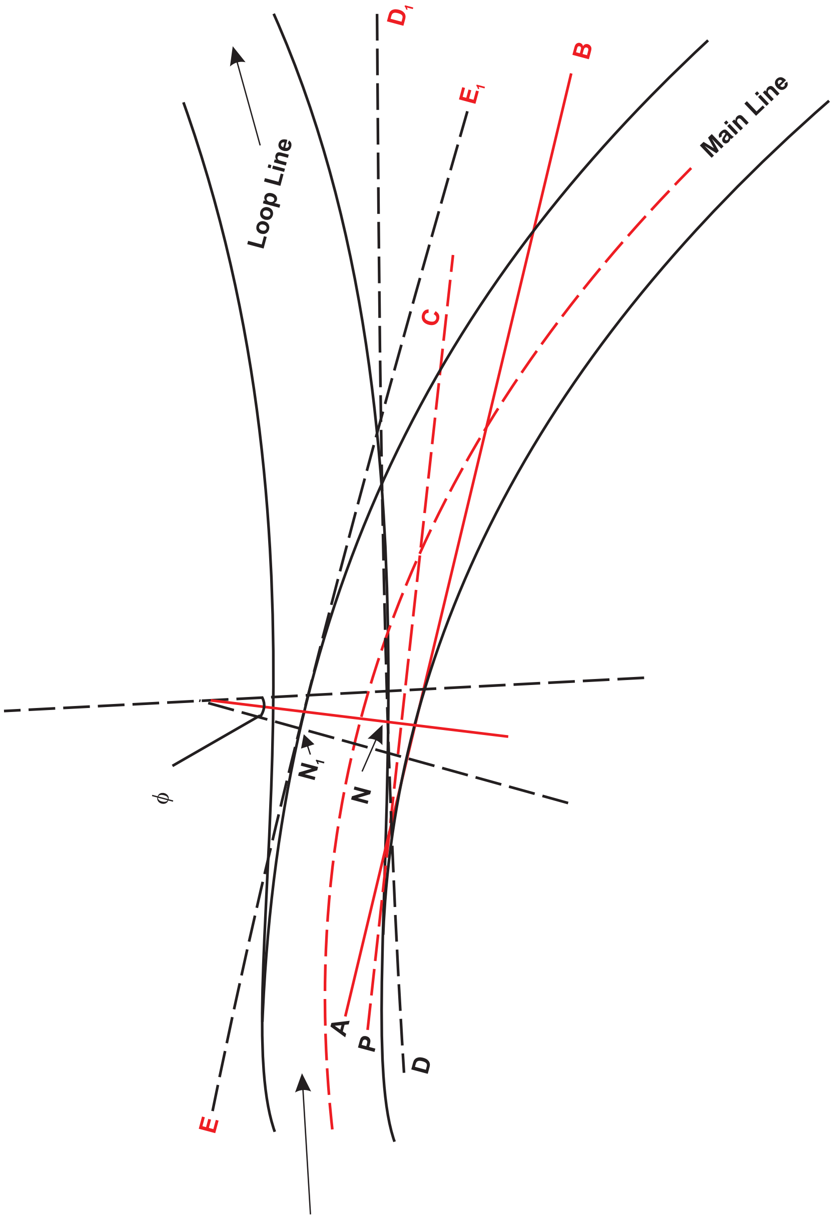


Fig. 6.13

Refer fig. 6.13 or 6.14 Angle CP_1B is δ, the angle between two tangents at ATS i.e tangents AB and PC

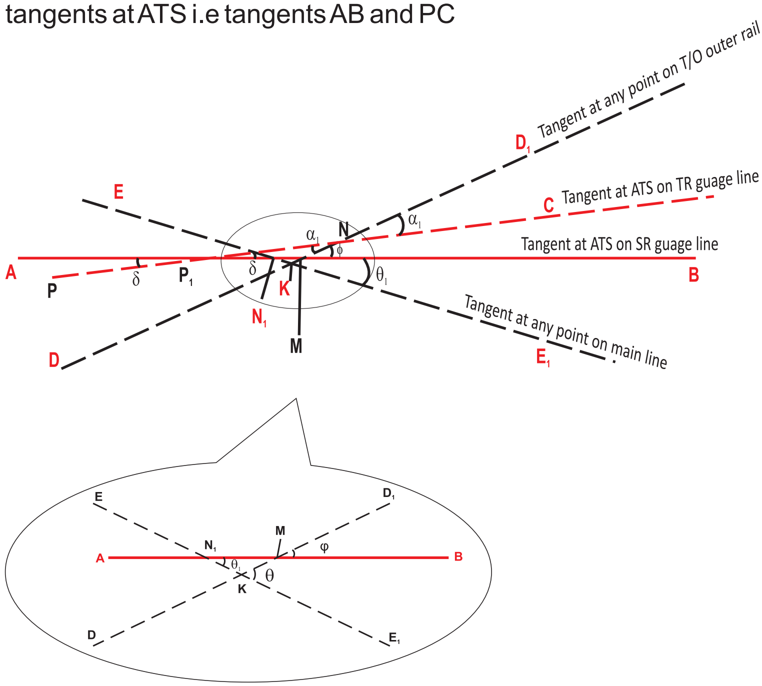


Fig. 6.14

Angle D_1NC is α or α_1 the angle between tangent D_1D at any point on outer rail of turnout lead curve, N with initial tangent PC.

Angle BN_1E_1 made between tangents EE_1 tangent AB is θ1. Consider Δ P_1NM angle P_1NM is α_1, being corresponding angle. Hence angle NMB is exterior angle to Δ P_1MN and is equal to δ + α_1, denoted as φ

The angle between two tangents i.e. tangent on main line curve EE_1 and tangent on turnout lead curve DD_1 at point N (or K) (refer abstract figure) is angle D_1KE_1 = angle D_1MB + angle BN_1K.

Or, $\theta = \varphi + \theta_1 = \delta + \alpha_1 + \theta_1$ this is also the angle between two normal at point N. hence the sleeper orientation will be at half the angle from normal to tangent on mainline and normal to tangent on turnout lead curve at N i.e. θ/2.

Example 3 : (a) Find Sleeper Spacing for 21st sleeper when 1 in 12 turnout takes off in contarary flexure:

Consider 1 in 12 turnout taking off from 1° main line curve in contrary flexure. Sleeper is oriented at $\theta/2 = (\delta + \alpha_1 + \theta_1)/2$, where;

δ = Switch entry angle = 0° 20' 0" = 0.333 deg=0.00581776 rad.

α_1 = X/Rrl , where X is distance of point under consideration measured along main line from ATS and Rrl is resultant radius of lead curve.

θ_1 = X/ Rm, where Rm is radius of main line curve. Now refer Fig. 6.15, S_1 given spacing on the main line side where crossing is situated is 526 mm, X at 21st sleeper is 9986 mm,

Rm =1750000 mm,

Resultant radius of turnout Rrl = 1/(1/Rm-1/Rt/o)

= 1/(1/1750-1/441.36)

= 590.216m = 590216 mm

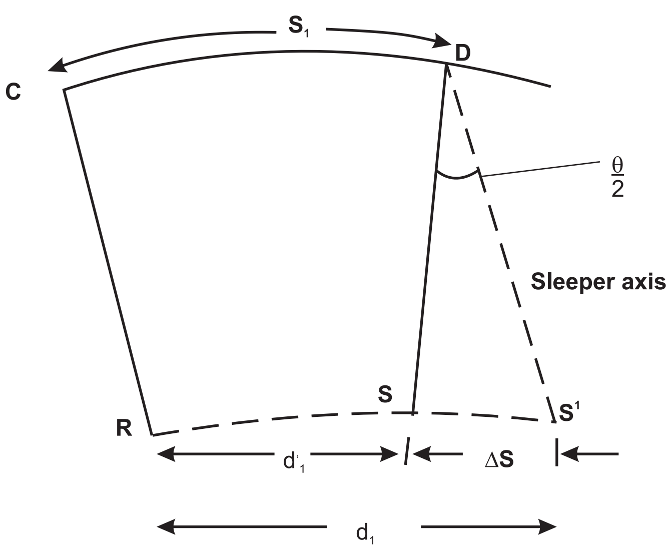


Fig. 6.15

α_1 = X/Rrl = 9986/590216 = 0.01691923

θ_1 = X/Rm =9986/1750000 = 0.00570628

Sleeper spacing on other side $S_{21}=d_1 = d'_1 + \Delta S_1$

Where $d'_1 = d_1*(Rm - G/2)/(Rm + G/2)$

= 526* (1750000-1673/2)/(1750000+1673/2)

= 525.49738 mm

$\Delta S_1 = G * (\delta + \alpha_1 + \theta_1)/2$

= 1673*(0.00581776 + 0.01691923 + 0.00570628)/2

= 23.7928

Hence d_1= 525.49738 + 23.7928 = 549.3 mm

(b) Sleeper spacing for 22nd and onwards in lead portion:

Now refer Fig. 6.16 d_2 i.e. TT_1 is the required sleeper spacing for 22nd sleeper on a side where crossing does not lie. As can be seen from this figure S_{22} and d'_2 are spacing of a curve on outer side and inner side respectively. Look at $DSTT_1ED$

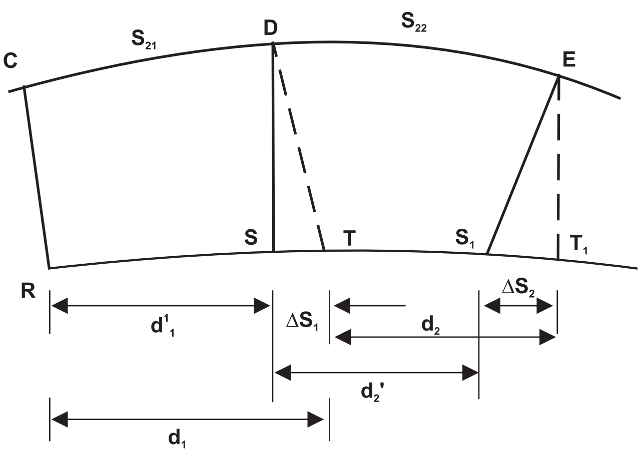


Fig. 6.16

$d_2 = TT_1 = d'_2 + \Delta S_2 - \Delta S_1$, where;

$d_2' = S_{22}*(Rm-G/2)/(Rm+G/2)$;

$\Delta S_2 = G*(\delta + \alpha_2 + \theta_2)/2$

$\Delta S_1 = G^* (\delta + \alpha_1 + \theta_1)/2$

Hence $d_2 = S_{22} {}^*(Rm-G/2)/(Rm+G/2) + G^*(\delta + \alpha_2 + \theta_2)/2$

$- G^* (\delta + \alpha_1 + \theta_1)/2$

where; S_{22} is sleeper spacing on the side where crossing is situated. α_2 is angle between tangent drawn on lead curve at 22nd sleeper with initial tangent drawn at ATS on gauge line of TR on lead curve. θ_2 is angle between tangent drawn on main line corresponding to 22nd sleeper and the initial tangent at ATS on gauge line of SR of main line curve. Other terms are as explained earlier.

The spacing for other sleepers i.e. 23rd to 65th in lead portion are calculated in similar way. The spacing from 66th sleeper to 83rd sleeper will be perpendicular to bisector of crossing and can be worked out simply by readjusting the sleeper spacing corresponding to outer side of curve (having larger dimension) and inside of curve (having lesser dimension), using the same principle as done in switch portion side equation (1). In case of similar flexure sleeper spacing on B side or outer most side will be (Refer Fig. 6.18)

$d_2 = 550 \times (Rm + G/2) / (Rm - G/2 - O)$

and innermost side of turnout the same is given as

$d_1 = 550 \times (Rm - 3G/2 - 2O) / (Rm - G/2 - O)$

Where O is offset at any point in crossing zone from HOC at a distance 'x' and given as $O = x \tan F/2$

Similarly for contrary flexure turnout the spacing on 'B' Side or Inner most side after HOC is given

$d_2 = 550 \times (Rm - G/2) / (Rm + G/2 + O)$

and on outer most side of turnout rail will be given as

$d_1 = 550 \times (Rm + 3G/2 + 2O) / (Rm + G/2 + O)$

The sleeper spacing for similar and contrary flexures have been worked out and given in annexure 4 to 9. In case of similar flexure the spacing is given only for curve upto 2 deg main line.

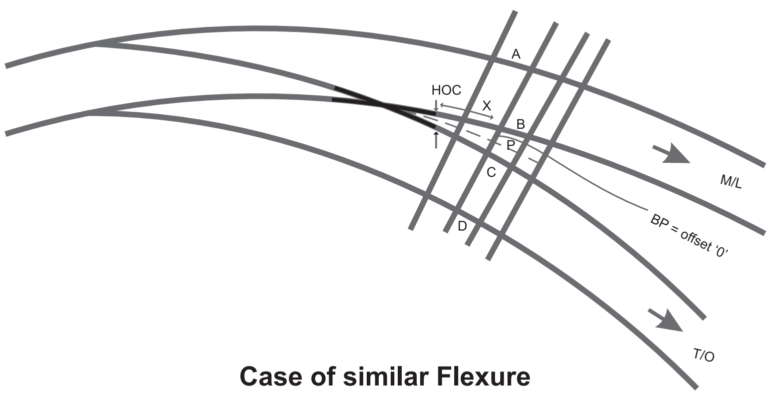
For contrary flexure upto 4 degree main line, the above formula works but for 1 in 12 turnout taking off from 5 degree in contrary flexure it is slightly different because in that case both main line and turnout flex in same direction. For calculation of spacing then refer Fig. 6.18, page 140.

From figure it can be seen that angle between two tangents at any point in lead curve θ is given as = $\theta_1 + \delta - \alpha_1$. In that case the sleeper spacing S_{21} and S_{22} are given as;

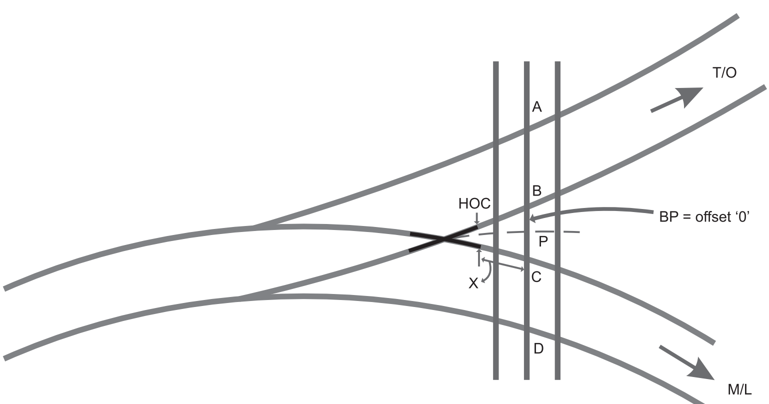
$$S_{21} = d_1*(Rm - G/2)/(Rm + G/2) + G*(\delta - \alpha_1 + \theta_1)/2$$

$$S_{22} = d_2*(Rm-G/2)/(Rm+G/2) + G*(\delta - \alpha_2 + \theta_2)/2 - G*(\delta - \alpha_1 + \theta_1)/2$$

On similar lines the spacing for 1 in 8.5 has been worked out and is given in Annexure 8 & 9.



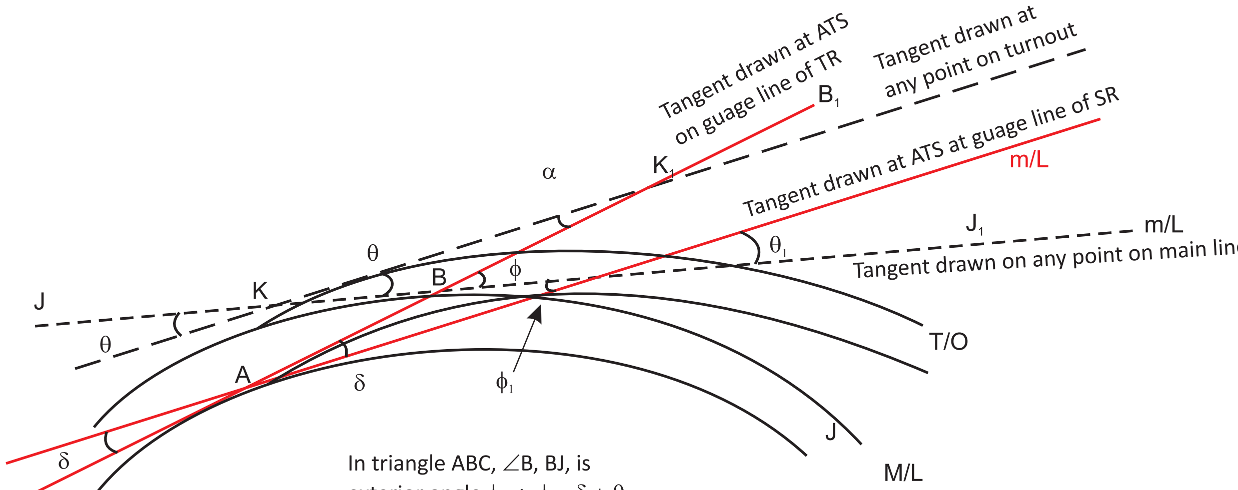
Case of similar Flexure



Case of Contrary Flexure

Fig. 6.17

Contrary Flexure : 1 in 12 taking off from 5^o curve
(In this case the orientation of curve changes)



In triangle ABC, $\angle B$, BJ, is
exterior angle ϕ, $\therefore\ \phi = \delta + \theta_1$
This is also exterior angle to triangle KBK1
Hence $\phi = \theta + \delta$
$\theta = \theta_1 + \delta - \alpha$

Fig. 6.18

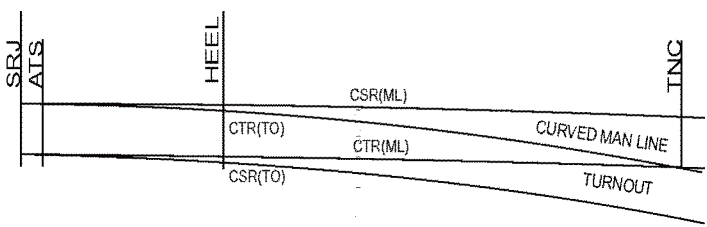
6.3 (a) Pre-curving of Tongue & Stock Rails in 1:12, 60 Kg Turnout With Zu-1-60 Thick-Web Switches

RDSO's letter no- CT/PTX/TWS Design dated 27.07.2018

Considering the extant provisions of IRPWM & satisfactory field performance report of 1 in 12 thick-web switches laid on curves, received from zonal railways, pre-curving requirements of both stock & tongue rails of 1 in 12 thick-web switches to drawing no. RDSO/T-6155 for similar flexure & contrary flexure turnouts taking off from curved mainline has been calculated as shown in table below. The tongue and stock rails of such 1 in 12 thick-web switches shall be given requisite amount of pre-curving at manufacturing premises. The measurement of mid and quarter ordinates both for stock & tongue rails of 1 in 12 similar flexure & contrary flexure turnouts with thick-web switches shown in Table 6.4, 6.5 and 6.6

Table 6.2

Pre-curvature for 1 in 12 Similar FlexureTurnout:



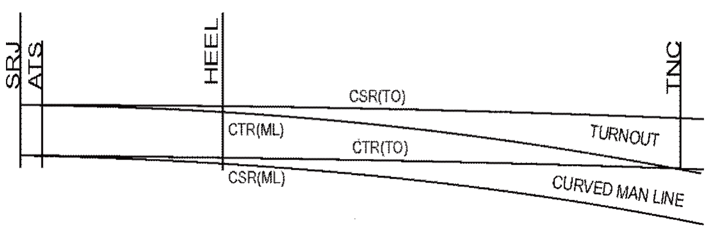
Degree of Main line Curve	Main Line (Versine)				Turnout (Versine)			
	CSR (mm)		CTR (mm)		CTR (mm)		CSR (mm)	
	A (MID)	B	C (MID)	D	E (MID)	F	G (MID)	H
up to 0.5^0	0	0	0	0	44	33	40	30
$>0.5^0$ & up to 1.0^0	10	7.5	11	8.5	55	41.5	50.0	37.5

6.3 (b) Pre-curvature of tongue/stock rail

For normal fan shaped- It is a known fact that the curved switch manufactured for LH turnout can not be used for RH turnout. In every curved switch, gauge face of pair of tongue rail and stock rail leading to turnout side is made curved. Back of the curved tongue rail is machined straight up to JOH, as this is supposed to bear against straight stock rail. Curved stock rail and tongue rail are supposed to have certain predefined pre-curvature. Such pre-curvature is supposed to be given by manufacturer before dispatch. While laying fan shaped turnout on straight track, only one stock rail and tongue rail for turnout side is required to be checked for pre-curvature (by checking mid and

Table 6.3

Pre-curvature for 1 in 12 contrary FlexureTurnout:

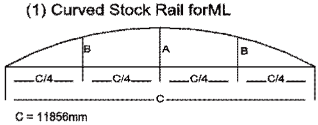


Degree of Main line Curve	Main Line (Versine)				Turnout (Versine)			
	CSR (mm)		CTR (mm)		CTR (mm)		CSR (mm)	
	A (MID)	B	C (MID)	D	E (MID)	F	G (MID)	H
up to 0.5^0	0	0	0	0	44	33	40	30
>0.5^0 & up to 1.5^0	10	7.5	11	8.5	33	25	30	22.5
>1.5^0 & up to 2^0	20	15	22.5	17	22	16.5	20	15

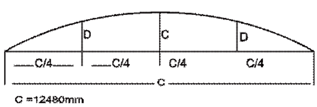
quarter ordinate). This will ensure proper curvature and proper setting of tongue rail. If this is not done properly this will reflect in to versine and gauge readings in the switch. Ordinates at mid and quarter point to be ensured are given in the relevant drawings. However these versine values are only true when turnout is laid on straight main line. In case of laying of fan shaped turnouts on curved track both the stock and tongue rails become curved and the pre-curvature requirements change according to the degree of curve and whether it is similar flexure or contrary flexure.

SimilarFlexureTurnout

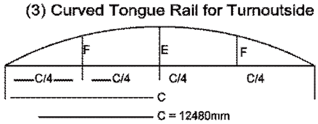
(1) Curved Stock Rail forML



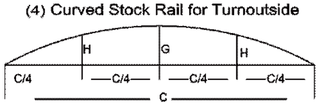
(2) Curved Tongue Rail forML



(3) Curved Tongue Rail for Turnoutside

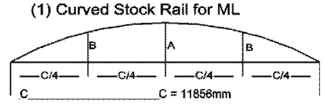


(4) Curved Stock Rail for Turnoutside

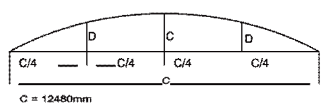


Contrary FlexureTurnout

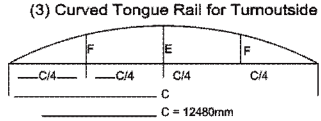
(1) Curved Stock Rail for ML



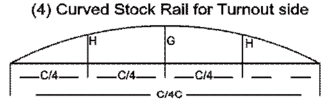
(2) Curved Tongue Rail forML



(3) Curved Tongue Rail for Turnoutside



(4) Curved Stock Rail for Turnout side



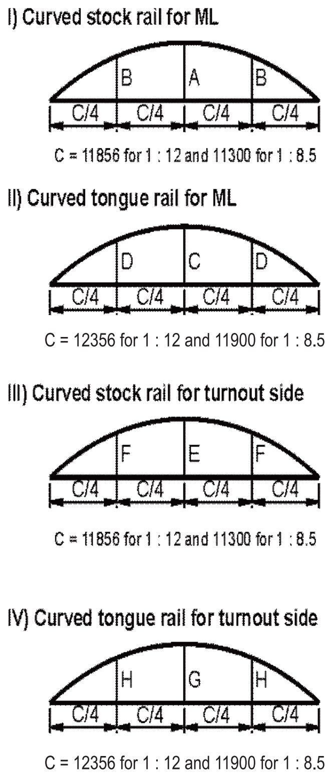


Fig. 6.6 for Similar Flexure

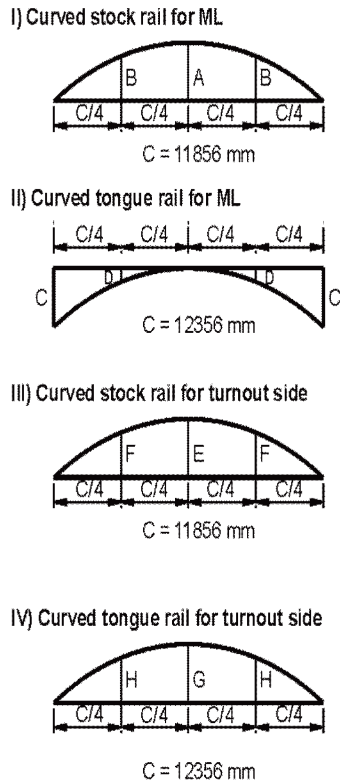


Fig. 6.6 for Contrary Flexure

So to ensure proper bearing of both the tongue rails proper pre-curvature is required. As discussed earlier, pre-curvature requirements change according to the degree of main line curve and flexure of turnout (similar or contrary).

Hence separate tables have been prepared for 1 in 12 similar flexure, contrary flexure and 1 in 8.5 contrary flexure turnouts (Tables 6.4, 6.5 and 6.6). It is also pointed out that it may not be possible to measure positive versine of one of the tongue rail of similar flexure (i.e. tongue rail for mainline side); hence the measurements of mid and quarter point should be done as explained in fig.6.6 and fig.6.7. These sketches should always be referred while using the tables to avoid confusion.

Table 6.4 Pre-Curvature For 1:12, Similar Flexure Turnout

Degree of Main line Curve	A	B	C	D	E	F	G	H
0	0	0	0	0	40	30	43	32
1	10	7	11	8	50	37	54	40
2	20	15	22	16	60	45	64	48
3	30	22	33	25	70	52	75	56
4	40	30	44	33	80	60	86	64

Table 6.5 Pre-Curvature For 1:12, Contrary Flexure

Degree of Main line Curve	A	B	C	D	E	F	G	H
0	0	0	0	0	40	30	43	32
1	10	7	11	3	30	22	32	24
2	20	15	22	6	20	15	21	15
3	30	22	33	8	10	7	10	7
4	40	30	44	11	0	0	0	0

Table 6.6 Pre-Curvature For 1:8.5, Contrary Flexure

Degree of Main line Curve	A	B	C	D	E	F	G	H
0	0	0	0	0	69	52	31	23
1	9	7	4	3	61	44	27	20
2	18	14	8	6	51	38	23	17
3	27	21	12	9	42	32	19	14
4	36	27	17	12	33	24	15	10

Note:

1) The issue of giving bend was discussed in TSC's 73rd meeting during Feb.2002 vide item No. 980(6) and it was discussed that necessary bending of rails is to be done carefully avoiding any sudden application of force. Same care may be taken while correcting pre-curvature.

ii) Table 6.4, 6.5 and 6.6 have been made by author (not circulated by RDSO). Hence, before its use, necessary consultation with concerned authority should be done.

6.4 Provision of small check rail near ATS: In case of similar flexure turnout, tongue rail leading to turnout side wears out very fast. This happens because of persistent angle of attack on tongue rail by wheel. This may require replacement/ reconditioning of tongue rail at very high frequency. Similar phenomenon may be observed on contrary flexure turnouts for tongue rail leading towards main line. In order to deal with such problem a small check rail can be provided on inner rail near/before ATS. Experience have shown that wear of tongue rail of similar flexure turnout get reduced after installation of such check rail. RDSO has issued drawing vide their Drg. No. RDSO/T-6076 (for 60kg rail).This drawings can be used on 1 in 8.5 as well as 1 in 12 turnouts. Length of check rail is 2300mm for 1 in 12 as well as for 1 in 8.5. It is to be fixed on sleeper no. 2AS, 1AS, 1 and 2. Gap between ATS and end of check rail has been kept 250mm for 1 in 12 and 300mm for 1 in 8.5 turnouts. A schematic diagram of such check rail has been shown in fig. 6.8.

Feedbacks from field engineers indicate that use of such check rails is helpful in reducing wear of tongue. So use of small check rail on turnouts laid on curve is strongly recommended.

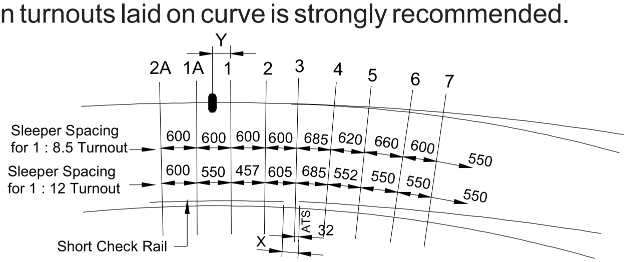
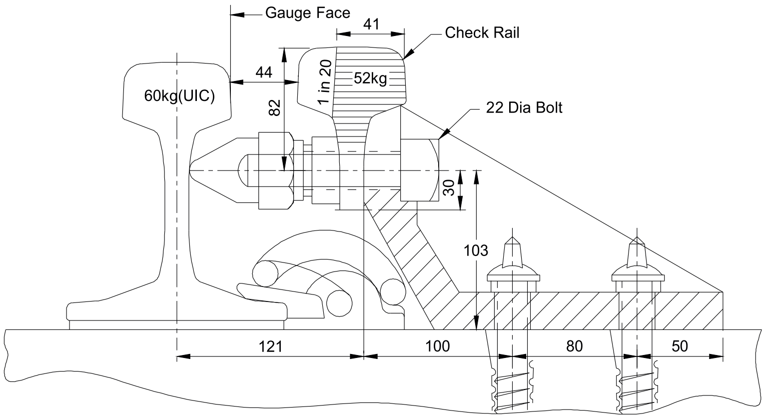
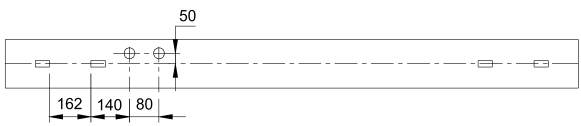


Fig. 6.8 (A) Small check rail on similar flexure





PSC SLEEPER No. 1, 2, 1A & 2A

Fig. 6.8 (B) Details of small check rail for similar flexure RDSO drawing no. T-6076

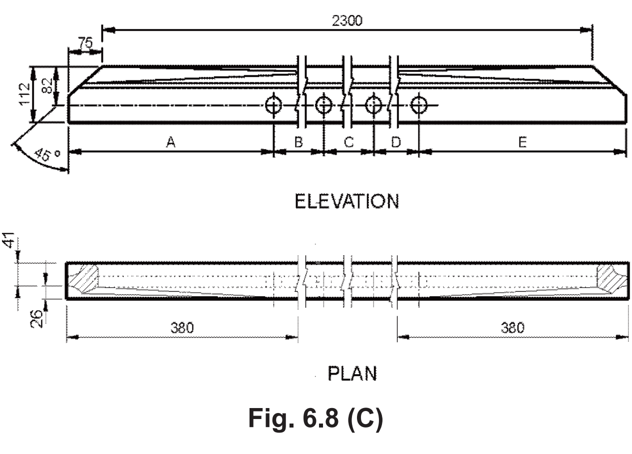


Fig. 6.8 (C)

TURNOUT	A	B	C	D	E	X	Y
1 IN 12	356	600	550	457	337	250	150
1 IN 8.5	118	600	600	600	382	300	268

Note :

1. *This arrangement can be adopted upto 2^0 Main Line Curve laid in similar flexure.*
2. *Holes for dowels for fixing C.I. bracket may be drilled in four PSC Sleeper No.*
3. *All dimensions are in mm*

It may also be noted that the location of holes to be drilled in the rail to be used as check rail have been given as per sleeper spacing as per old drawing. Now since it has been modified by alteration no.5, and it is uniform 600mm, the holes location may have to be changed while maintaining the same “X” distance. This type of modification is yet to be issued by RDSO, hence this may be done after consultation with the concerned officials.

■ ■ ■

CHAPTER 7

IMPORTANT PROVISIONS FOR LAYING TURNOUT ON CURVE AND SPEED POTENTIAL

7.0 Introduction: The design of turnout has been made for laying it on straight main line, but because of peculiarities of various yards turnouts are required to be laid on curve. This brings in various issues regarding safety and speed potential of trains running over it. Many provisions have been stipulated in IRPWM and SOD in this regard.

7.1 Turnouts on Running Lines with Passenger Traffic (Para 408(2) of IRPWM): – Turnouts in running lines over which passenger trains are received or dispatched should be laid with 1 in 12 curved switch or flatter. (b) 1 in 8.5 turn out with curved switches can be laid in exceptional circumstances taking off from straight track with the approval of PCE. (c) Emergency crossovers between double or multiple straight lines, which are laid only in the trailing direction, may be permitted to be laid with 1 in 8½ crossings (d) For snag dead end, 1 in 8½ symmetrical split turnouts may be used. (e) The turnouts have inbuilt curvature as a part of the design. Therefore, it is desirable that laying of turnouts should normally be avoided on curved main line from the consideration of maintainability & comfort. If the laying of turnout on curved main line is inevitable due to site constraints, following stipulations shall be followed: (i) for laying of turnouts with 1 in 12 or flatter crossings taking off from curve, it shall be ensured that the resultant lead curve radius as well as the radius of main line curve shall not be less than 350m. (ii) 1 in 8.5 turnout shall not be laid from inside of a curved track (iii) 1 in 8½ turnout with curved switches may be laid from outside of a curve up to five degree in exceptional circumstances with the approval of PCE, where due to limitation of room it is not possible to provide 1 in 12 turnout. Note: The existing turnouts not conforming to the stipulations given in Sub-Para (e) above may continue.

However, efforts shall be made to eliminate such layouts in a planned manner

7.2 Turn-in-curve radius for turnouts laid on passenger running lines: Radius of turn in curve can be decided at the time of designing of yard. In case of 1 in 12, 1 in 16 or 1 in 20 turnout, designing the turn in curve with radius same as that of lead curve will take care of full speed potential of the turnout. However if the radius of turn in curve is required to be reduced for space considerations the radius of turn in curve should not be sharper than minimum radius stipulated for lead curve i.e. for BG minimum radius should be more than 350m, for MG it should be more than 220m and NG it should be more than 165m. The same rule is applicable for 1 in 8.5 too; hence for 1 in 8.5 first attempt should be to provide turn in curve radius of atleast 350m. Where it is practically not possible to achieve such radius on account of **existing track centre for turnouts taking off on the curve** the radius of turn in curve may be reduced up to 220m for BG and 120m for MG subject to following conditions:

(a) Such turn in curves should be provided either on PSC or steel trough sleepers only, with sleeper spacing same as for the main line.

(b) Full ballast profile should be provided as for track on main line.

7.3 Permissible Speed over curved Main line at Turnouts –

7.3.1 Provision in general rules - Relevant para 4.10 of General Rules, 1976 Edition is reproduced below:

"(a) The speed of trains over non-interlocked facing points shall not exceed 15 kilometer per hour in any circumstances and the speed over turnouts and crossovers shall not exceed 15 kilometer per hour, unless otherwise prescribed by approved special instruction, which may permit a higher speed.

(b) Subject to provision of sub-rules (a) a train may run over interlocked facing points at such speed as may be permitted by the standard of interlocking."

7.3.2 Permissible speed on the main line –

The permissible speed on the main line is determined from the allowable cant deficiency and maximum cant on the main line. The permissible speed on the main line will be worked out by the formula as given in para 405 of IRPWM. The speed so determined shall be subject to the permissible run through speed governed by the standard of interlocking and the sectional speed.

7.3.3 Provision of super-elevation over turnouts –

There should be no change of cant between points 20 meter on B. G., 15 meter on M. G., and 12 meter on N. G. outside the toe of the switch and the nose of the crossing respectively.

Normally, turnouts should not be taken off the transitioned portion of a main line curve. However, in exceptional cases, when such a course is unavoidable a specific relaxation may be given by the Chief Engineer of the Railway. In such cases also change of cant should not be allowed as above.

Effective radius of turnout - In case the turnout is taking off from inside of the mainline curve as shown in following Fig. 7.1, then flexing direction of the effective curve on turnout is always same as that of the main line curve.

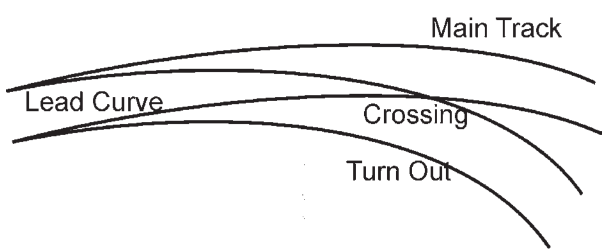


Fig. 7.1 Turnout taking off from inside of main line curve.

In case the turnout is taking off from outside of the mainline curve, then flexing direction of the effective curve on turnout will be in the direction of curve of sharper curvature as shown in Fig. 7.2.

If the flexing of the effective curve is same as that of the main line then the turnout is called similar flexure otherwise contrary flexure. The flexing of turnout shall not be confused with the left/right hand (LH/RH) turnout.

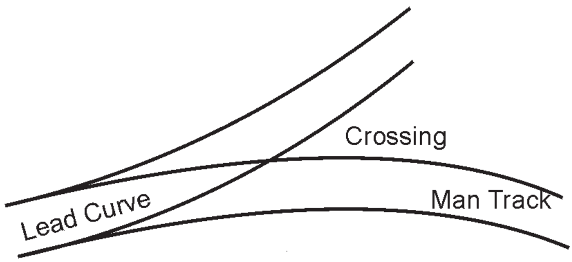


Fig. 7.2 Turnout taking off from outside of main line curve.

For example, for right hand (RH) main line curves if turnouts flex in RH then it is similar flexure turn out. Further if turn out is taking off from the inner rail of the main line curve then it is similar flexure turnout, otherwise if turnout takes of from outer rail of main line curve then turn out is contrary flexure turn out.

7.3.4 Speed on contrary flexure – In the case of contrary flexure, the cant provided on mainline becomes negative cant for the turnout. The maximum cant on the main line is the difference between the maximum permissible cant deficiency and equilibrium cant required for turnout.

The permissible speed on the main line is then determined from the allowable cant deficiency and maximum cant on the main line. Following steps are followed for calculating speed on main line.

Step-1: Find out effective radius of turnout,

$$\frac{1}{Re} = \frac{1}{Rm} \quad \frac{1}{Rt}$$

Step-2: Find out equilibrium cant required for turn out track, where trains are permitted to run with speed V_t

$$SE_{t/0} = \frac{GV_t^2}{127Re}$$

For B G $SE_{t/0} = \frac{13.76V_t^2}{Re}$ assuming G = 1750 mm and for

For M.G. $SE_{t/0} = \frac{8.32V_t^2}{Re}$ assuming G = 1057 mm

Step - 3: Cant on main line shall be equal to Ca = Cd - $SE_{t/0}$ where Cd is is the maximum cant deficiency permitted on the turnout.

Step - 4: Maximum Permissible speed on main line can now be calculated as per the formula for safe speed on curves para 405 of IRPWM.

7.3.5 Curves of similar flexure – In the case of similar flexure, cant on turnout is positive. The maximum cant on the main line is the sum of equilibrium cant for the turnout and maximum permissible cant excess.

The permissible cant on main line is restricted for the following situations:

(i) Turnout not followed by reverse curves - On a main line curve from which a curve of similar flexure takes off, not followed immediately by a reverse curve, the turnout curve shall have the same cant as the main line curve.

(ii) Turnout followed by reverse curves – A change of cant on the turnout may be permitted starting behind the crossing and being run out at a rate not steeper than 2.8 mm/m and subject to the maximum cant on the main line turnout being limited to 65 mm. on Broad Gauge, 35 mm on Meter Gauge and 25 mm on Narrow Gauge (762 mm)

The permissible speed on the main line is then determined from the allowable cant deficiency and maximum cant on the main line.

Following steps are performed for calculating the speed on main line

Step-1: Find out effective radius of turnout,

$$\frac{1}{Re} = \frac{1}{Rm} \quad \frac{1}{Rt}$$

Step-2: Find out equilibrium cant required for turn out track, where trains are permitted to run with speed V_t

$$SE_{t/0} = \frac{GV_t^2}{127Re}$$

For B.G. $SE_{t/0} = \frac{13.76V_t^2}{Re}$ assuming G = 1750 mm and

For M.G. $SE_{t/0} = \frac{8.32V_t^2}{Re}$ assuming G = 1057 mm.

Step-3: Cant on main line shall be equal to Ca = Cex + SE

Step-4: Calculate Maximum Permissible speed on main line as per para 405 of IRPWM.

Example 7.01 – Find out the maximum permissible speed on the main line curve, if permissible speed on 1 in 12 turnouts is 30 km/h. Turnout is taking off from outside of curve. If degree of main line curve is (a) 3° and (b) 5°

Solution:

For 1 in 12 turnout R = 441.36 mt

(a) R_m = 1750/3 = 583.33 m

Step 1 : Find out effective radius of turnout

$D_R = D_{t/o} - D_m = 4 - 3 = 1^0$

Hence effective lead radius of turnout = 1750 m.

Step 2 : Find out equilibrium cant required for turnout track, when trains are permitted to run with 30 Kmph

$$SE_{t/o} = \frac{1750 \times 30^2}{127 \times 1750} = 12.4 \text{ say } 13 \text{ mm}$$

Step 3 : Turnout can be permitted with negative cant of 75 -13 = 62 mm, hence main line cant will be 62 mm.

Step 4 : Find maximum speed on main line with this cant of 62 mm

$$V_{max} = 0.27\sqrt{R\,(C_a + C_d)} \quad = 0.27\sqrt{583.3\,(62 + 75)}$$

$$= 76.32 \text{ say } 75 \text{ Kmph.}$$

(b) With main line degree of curve = 5^0

Step-1 finding the equivalent radius of lead curve of turnout;

$$D_r = D_m - D_{t/o}$$
$$= 5 - 4 = 1$$

Hence resultant radius of lead curve = 1750 m

Step-2: Find out equilibrium cant required for turn out track, where trains are permitted to run with speed say V_t

$$SE_{t/0} = \frac{1750 \times 30^2}{127\times1750} = 12.4 \text{ mm say } 12 \text{ mm.}$$

Step3: Since in this case the turnout also takes the orientation on same side that of main line curve, Turnout can be permitted with cant excess of 75 mm,

hence permitted cant on main line = 75+12 = 87 say 85 mm and hence main line cant will be 62 mm.

Step-4 ; find maximum speed on main line with this cant provided;

$$Vmax = 0.27\sqrt{R(Ca+Cd)}$$
$$= 0.23\sqrt{350(85+75)}$$
$$= 63.89 \text{ say } 60 \text{ Kmph}$$

Example 7.02 – A 1 in 12 turnout takes off from inside of a 4° curve; find out the maximum permissible speed on the main line if permissible speed on turnout is 30 km/h (a) Turnout not followed by reverse curves and (b) Turnout followed by reverse curves.

Solution:

R_m = 1750/4 = 437.5 m

R = 441.36 mt

Step-1: Find out effective radius of turnout,

$$\frac{1}{R_e} = \frac{1}{Rm} + \frac{1}{R_t} = \frac{1}{437.5} + \frac{1}{441.36} \Rightarrow R_e \cong 220 \text{ m}, < 350 \text{ m}$$

may be permitted under exceptional circumstances.

Step-2: Find out equilibrium cant required for turn out track, where trains are permitted to run with speed say V,t

$$SE_{t/0} = \frac{1750 \times 30^2}{127 \times 220} = 56.37 \text{ mm say 55 mm.}$$

(a) Turnout not followed by reverse curves

Step-3: Cant on main line shall be equal to

$C_a = C_{ex} + SE_{t/0} = 75 + 55 = 130$ mm

Step-4: Maximum Permissible speed on main line

$$\text{Vprm} = 0.27\sqrt{R_m(C_a + C_d)} = 0.27\sqrt{437.5(130 + 75)}$$

= 80.86 km/h Say 80 km/h

(b) Turnout followed by reverse curves

Step-3: Cant on main line shall be equal to

C_a = 131.37 mm > 65 mm, Not O.K. C_a = 65 mm

Step-4: Maximum Permissible speed on main line

$$\text{Vprm} = 0.27\sqrt{R_m(C_a + C_d)} = 0.27\sqrt{437.5(65 + 75)}$$

= 66.82 km/h Say 65 km/h

7.3.6 Curves with crossovers –

On curves on double line connected by crossover road, the speed and the cant for both roads are governed by the inner road to which the cross over road is a curve of contrary flexure. On the outer road, it is a curve of similar flexure as shown in Fig. 7.3.

The permissible speed and the necessary cant on the inner road shall be calculated in accordance with para 7.3.4. The same speed and the same cant shall be allowed on the outer road.

The outer track shall be raised so that both roads lie in the same inclined plane in order to avoid change in cross-level on the cross over road. Where this is not possible, both main line and the turnout should be laid without cant and suitable speed restriction imposed.

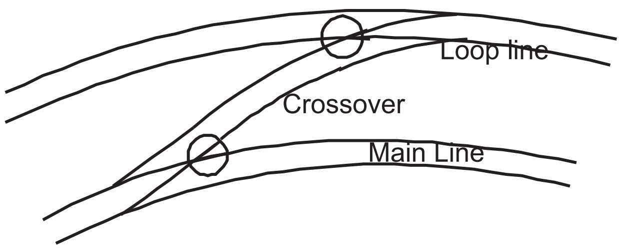


Fig. 7.3 Crossover joining curved main line and loop line

7.3.7 Curves with diamond crossing – Normally straight diamond crossings should not be provided in curves as these produce kinks in the curve and uniform curvature cannot be obtained. However, where provision of such diamonds cannot be avoided or in case where such diamonds already exists in the track, the approach curves of these diamonds should be laid without cant for a distance of at least 20 m. on either side of the diamond crossings. Cant should be uniformly run out at the rate specified in para 405 of IRPWM beyond 20m. The speed restrictions on the approach curve shall be decided in each case by the Chief Engineer taking into consideration the curvature, cant deficiency and lack of transition but shall in no case be more than 65 km/h in the case of Broad Gauge, 50 km/h in the case of Metre Gauge and 40 km/h in the case of Narrow Gauge (762 mm). No speed restriction shall, however be imposed on the straight track on which the diamond is located. In the case of diamond crossings on a straight track located in the approach of a curve, a straight length of minimum 50 m. between the curve and the heel of acute crossing of diamond is necessary for permitting unrestricted speed over the diamond, subject to maximum permissible speed over the curve from considerations of cant deficiency, transition length etc.

7.4 Raising of speed on turnouts: Normally the speed of train over turnout and cross over shall not exceed 15kmph unless otherwise approved by special instructions (In terms of GR 4.10). Speed in excess of 15kmph may be permitted on turnout side for 1 in 8.5, 1 in 12 and flatter turnouts provided with curved switches under approved special instructions in terms of GR 4.10 while taking care of provisions of para 408 (4) of IRPWM. Following are the important provisions of Para 408 (4) regarding up-gradation of speeds on turnouts and loops to 30kmph:

a) **Length of section –** Up-gradation of speeds on turnout should cover a number of contiguous stations at a time so as to derive a perceptible advantage of the higher speed in train operation.

b) **Turnouts –** Speed, in excess of 15kmph should be permitted on turnouts laid with ST or PRC sleepers only (not on wooden sleepers). All turnouts on the running loops shall be laid with curved switches, with minimum rail section being 52 kg. All rail joints on these turnouts should also be welded to the extent possible.

For different type of curved switches, speed permitted is as under (as per IRPWM para 410(4)): -

SN	Type of turnout (BG)	Permissible speed
1.	1 in 8.5 curved switch	15kmph
2.	1 in 8.5 symmetrical split with curved switches	30kmph
3.	1 in 12 curved switch	30kmph

Note: The permissible speed for 1 in 12 TWS is 50 Kmph

c) **Track on running loops –** Speed in excess of 15kmph, should not be permitted on running loops laid with wooden sleepers. The minimum track structure on the running loops should be 90R rails laid as Short Welded Panels, M+4 density on PRC, ST, CST-9 sleepers and 150 mm ballast cushion. Out of

150 mm total cushion, clean cushion of 75mm at least should be available. Proper drainage of the area should also be ensured. Wherever loops are laid on PSC sleeper with 52/60 kg rail with adequate ballast cushion and minimum sleeper density of 1540 nos per km the speed can be permitted upto 50 Kmph.

d) Turn in curves - Turn in curves should be laid with the same rail section as that of turn out with PRC sleepers with sleeper spacing being 65 cm centre to centre (maximum). Turn in curve should conform to Para 408 (2) of IRPWM and especially so in respect of curvature of the lead curve. Extra shoulder ballast of 150 mm should be provided on outside of the turn in curve. The frequency of inspection of turn in curves should be same as that for main line turnouts.

e) While intending to raise the speed over any section, speed potential of each and every turnout including turn in curve should be checked. For the turnouts taking off on the inside of curve the permissible speed should be determined for the resultant radius of lead curve. This issue has been dealt in details in para 7.3.

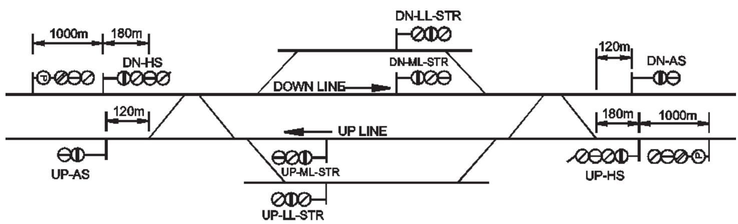
7.5 Raising of speed beyond 30kmph on loop line (Rly Bd Letter No. 2000/CE-II/TK19 dt. 24.1.07): Following are the speed potential of various turnouts available on the Indian Railways: -

Description	Speed\ (kmph)
1 in 8.5 T/O with Straight Switch	10
1 in 8.5 T/O with curved switch	25
1 in 12 T/O with straight switch	15
1 in 12 T/O on PSC sleepers (SEA 0^{0}20'00")	50
1 in 12 T/O with thick web switch on PSC sleeper	50
1 in 16 improved T/O with curved switch.	65
1 in 20 improved T/O with curved switch	85
1 in 8.5 symmetrical split T/O with curved switch	40
1 in 12 symmetrical split T/O with curved switch	70

1 in 16 symmetrical split T/O with curved switch	75
1:12 Turnout (60 Kg) with thick web switch on PSC sleepers	50
1:16 Turnout (60 Kg) with thick web switch on PSC sleepers	65

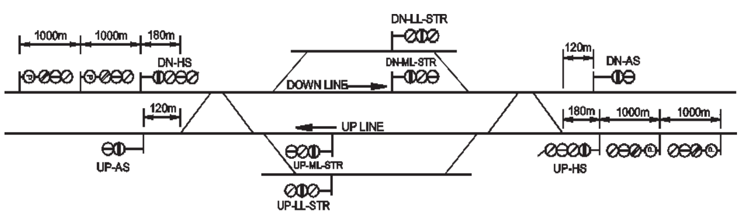
It can be seen from the above table that for broad gauge, many turnouts of modern design with speed potential much higher than 30kmph are available. 1 in 8.5 curved switch turnouts with symmetrical split on PSC sleepers provide speed potential of 40kmph, whereas 1 in 12 turnouts with curved switch on PSC sleeper of speed potential 50kmph is available. On most of the loops on Indian Railways, 1 in 12 turnouts are available on the passenger negotiating line except at sand hump point where 1 in 8.5 symmetrical split turnouts are available. Hence with this arrangement permissible speed of 40kmph is possible on loop line without any major changes if a train has to go through the loop. However, if ordinary 1 in 8.5 symmetrical split on the loop line sand hump is replaced by either 1 in 8.5 thick web symmetrical split or 1 in 12 turnouts, speed potential can be raised to 50kmph. Similarly on loop line wherever D/S are existing they are to be replaced with suitable D/S of thick web switch as per RDSO drawing & guideline. This reference to drawing as circulated by RDSO for ordinary D/S is given in table 7.2. RDSO will issue D/S with thick web drawing shortly. Normally speed potential of turnout mostly depends upon switch entry angle and radius of lead curve.

While intending to raise speed beyond 30kmph on loop, issue of time available with the driver to apply brake after observing the aspect of loop starter becomes very important specially for the loaded goods train. In a yard constructed on curve, if main line is already occupied by a train, driver of the train passing through loop line may find very less visibility distance available for application of brake, after the driver finds that the signal at the starter on loop is red. This issue becomes very important for a speed more than 30kmph. Hence for this reason, while raising speed beyond 30kmph on loop lines, the signaling arrangements are required to be modified in such a way that driver while passing home signal is aware whether he is to run through loop line or he has to stop on the starter. Modified signaling arrangements are shown in figure 7.3 and 7.4.



Distance	Home	Movement	Loop Starter	Main Starter	Adv. Starter
Y	R	Stop at Home Signal	–	–	–
YY	R	Stop on Loop Line	R	–	–
G	Y	Stop on Main Line	–	R	R
YY	YY	Run through Loop Line	YY	--	G
G	G	Run through	--	G	G

Fig. 7.3 Four aspect Home and Single Distant Signals



Distance	Home	Movement	Loop Starter	Main Starter	Adv. Starter
YY	Y	Stop at Home Signal	–	–	–
G	YY	Stop on Loop Line	R	–	–
G	YY	Stop on Main Line	–	R	R
G	YY	Run through Loop Line	YY	--	G
G	G	Run through Mail Line	--	G	G

Fig. 7.4 Four aspect Home and Double Distant signals

7.5.1 Requirement of fixed infrastructure for increasing speed over turnout and loop lines to 50 kmph RDSO's letter no- No.CT/PTX/TO/ Speed dated 29.08.2018)

Requirement from Track Considerations:

(a) Turnouts - Speed of 50 Kmph should be permitted on turnouts laid with thick web curved switches on pre-stressed concrete (PSC) sleepers. These turnouts should be properly deep screened having minimum 150mm clean ballast cushion . All rail joints on these turnouts should be welded except joints at the end of tongue rail and crossing. Following turnouts have Speed Potential of 50Kmph:

SNo.	Type of turnout (BG)	Permissible Speed on diverging line
1	60 Kg 1:12 Turnout with thick web switch on PSC sleepers	50 kmph
2	60 Kg 1:16 Turnout with thick web switch on PSC sleepers	65 kmph

(b) Turnout taking off from curved track: The permissible speed of turnout curve may be lesser than that shown in table above in case of turnout is taking off from curved track. The speed potential of such turnout curve should be determined as per site condition from resultant radius of the turnout curve and cant provided, if any, which may be negative for turnout in contrary flexure. Regarding, laying of thick web switches on curved track, instructions issued vide RDSO's letter no. CT/PTX/TWS Design dated 27.07.2018 should be followed.

(c) Turn-in/Connecting curve - Turn-in/Connecting curve should have speed potential = 50 Kmph which will depend on radius of curve and the positive and negative cant, if any, available on such curve. In case of no cant, such curve should have minimum radius of 441 m (i.e. Radius of turnout curve for 1 in 12 turnout at SN. 1 of para (a) above). Turn-in curves should be laid with the same rail section as on the turn-out with PSC sleepers with sleeper spacing being 65 cm centre to centre (maximum). Extra shoulder ballast of 150 mm should be provided on outside of the turn-in curve. The same is applicable to any connecting curve of two turnouts in a cross-over between two main lines or between main line and loop lines.

(d) **The layouts of each and every turnout and cross-**overs over which 50 kmph is proposed to be introduced, including versines over turn-in curves, shall be checked for correct laying and geometrical defects in layout shall be rectified before approaching CRS for permitting the higher speed. This is necessary in order to eliminate high lateral oscillation due to layout defects, particularly as turnouts are laid without super-elevation and do not balance the centrifugal force generated during movement over the turnout and turn-in curves, which would increase due to higher speed.

(e) **Derailing switch -** Derailing switch, if available in loop lines should be replaced with turnout having speed potential 50Kmph or replaced with suitable derailing switch fit for 50Kmph.

(f) **Track on running loops -** The minimum track structure on the running loops including turn in curve for permitting 50 Kmph speed should be 52 Kg rails laid as SWR/LWR, M+7 density (i.e. 1540 nos. per km) on PSC sleeper and 250 mm ballast cushion. Out of 250 mm total cushion, clean cushion of at least 150 mm should be available.

Higher speed of 50 kmph may also be permitted on loop lines provided with ballastless track laid as per drawings and guidelines contained in RDSO's document No. CT-31 (for trial purpose) or constructed on Design and Build basis in terms of Board's instructions communicated vide letter No. 2011/Proj/9/2 dated 12.02.2016 or as amended from time to time.

(g) If speed of 50 Kmph is not permissible on account of (a) to (f) above, action such as provision of turnout with flatter angle in main line and loop lines, easing of curvature (i.e. increasing radius) of connecting /turn-in curve, replacing derailing switch with turnout etc is required which may involve shifting of turnout/derailing switch. In case there is any reduction in CSL, then such cases can be kept out of ambit for this purpose.

Table 7.1

i) Single Distant Territory:-

SN	Condition Signal	Distant Signal	Home Starter	Loop Starter	Main Starter Signal	Advanced
1	Stop at Home Signal	y	R	-	-	-
2	Stop on Loop Line	yy	y With route	R	-	-
3	Stop on main Line	yy	y	-	R	R
4	Run through loop line	yy	yy With route	y	-	G
5	Run through main line	G	G	-	G	G

ii) Double Distant Territory:-

SN	Condition Signal	Distant Signal	Inner Distant Signal	Home Signal	Loop Starter	Main Starter Signal	Advanced Starter
1	Stop at Home Signal	YY	Y	R	-	-	-
2	Stop on Loop Line	YY	YY	Y With route	R	-	-
3	Stop on main Line	G	YY	Y	-	R	R
4	Run through loop line	YY	YY	YY	Y With route	-	G
5	Run through main line	G	G	G	-	G	G

(h) In view of the anticipated higher oscillation of rolling stock due to increase of speed over loop lines, platform clearances should be thoroughly checked with respect to stipulated requirements and necessary correction of the alignment of loop line should be carried out before approaching CRS.

(i) Routes identified for permitting 50 kmph on turnouts should be provided with Weldable CMS crossings on such turnouts in a programmed manner as a desirable track structure to eliminate the fish plated joints adjoining the crossing. However, minimum requirement would remain CMS crossings with fish plated joints.

3. Requirements from signaling consideration

(a) Clamp Lock Point Machines are to be provided for turnouts with speed > 30 Kmph.

(b) Arrangement for detection of facing points (including siding points) to be available in loop line, if any. This is in accordance with Signal Engineering Manual Part-I.

(c) Aspects of Home Signal to be modified suitably so as to enable the loco pilot to know whether he is passing through the loop line/main line or has to stop on loop line/main line so that he can control the train speed accordingly. The aspect of distant signal in single distant territory and double distant territory is shown in Table 7.1

(d) The visibility of loop line starter signals should be such that the loco pilot entering the loop line at 50 Kmph is able to see the starter signal aspect well in time. Use of LED signals on loop line starters for better visibility is to be considered essential.

(e) Para 4.10 of General Rules, 1976 specifies that speed over turnout and crossovers shall not exceed 15 Kmph, unless otherwise prescribed by approved special instruction, which may permit a higher speed. Suitable provision for this will have to be made in Station Working Rules with approved special instructions to permit such higher speeds.

(f) It is suggested that 50 Kmph speeds on 1:12 turnouts (Thick web) may initially be tried preferably in select sections having Automatlc Train Protection (TPWS/TCAS) to control speed on turnouts so as not to exceed 50 Kmph while entering loop line and the driver is able to bring the train to halt short of starter signal. Furthermore, such trials are proposed to be done in a reasonable long & continuous stretch/section by multidisciplinary team.

4. Requirements from OHE Consideration:

(a) Requirement of re-alignment of OHE should be worked out prior to taking up civil work. Any modification in track Layout at turnout (e.g. increase in length of turnout along with radius of curvature) may require changes in the Overhead Equipment (OHE) Installation involving changes of the location of the obligatory locations at the turnout and also shifting of the nearby few locations along with adjustment of the contact wire/catenary wire/droppers in the concern tension lengths of OHE. These OHE modifications shall be decided by the Zonal Railways on case basis after studying the locations.

(b) Railway Board has issued directives vide letter no. 2001/Elect(G)/170/1 dated 22/23.12.2016 for contact wire gradient, Relative gradient, tension, presage of OHE etc. which should be implemented.

(c) OHE of loop line turnout shall be overlap type only.

(d) Before trial, feasibility study should be carried out for the provision of OHE structure at the new '-.Jlocations as per the revised chainage of track turnout layout. If suitable location (space) for the provision of OHE structure is not available as per the proposed chainage of the track then change of the track alignment should be considered. If change in track alignment is not possible, then suitable decision should be taken by the railway.

(e) Checking of OHE should be carried out initially with tower wagon. Parameters (various clearances as per TI/MI/0028 Rev. 2) should be recorded prior to tower wagon checking and after final adjustments. Electric loco trial should also be carried out.

5. Requirements from Power and Rolling Stock Consideration:

(a) In the first phase, higher speeds of 50 kmph on the turnout are proposed only for coaching trains. Freight stock, which does not have superior suspension like coaching stock and has higher lateral accel erati on, higher lateral thrust and less intensive under gear inspection regime, will be considered after gaining experience with coaching trains which have better suspension and better maintenance regime. Speed of freight trains can be kept at 30 kmph initially which can be reviewed after 12 months.

(b) Oscillation trial with heaviest and lightest freight and coaching stock should be conducted. Right Powering as stipulated by CRS should be ensured.

7.6 Speed over turn in curve: In most of the cases turn in curve starts immediately after crossing for connection of main line with loop line. In case of concrete sleepers, turn in curve starts from centre of last long sleeper except in cases where further straight have been provided after long sleepers. Various issues related to speed potential of turn in curve have been dealt in the following paragraphs.

7.6.1 Turn in curves where main line is straight and loop line is parallel to main line: While designing turn in curve in a yard, criteria for selection of its radius has been discussed in article 7.2 above. In case of straight main line, turn in curve will have reverse flexure as compared to lead curve. Even the sharpest possible radius of 220m for turn in curve will also be able to provide a speed potential of 36kmph. On Indian railway till date emphasis is to raise speed up to 30kmph on loop, so in such cases turn in curve doesn’t pose any special problem. In case speed is to be raised beyond 30kmph such a turn in curve will create bottleneck, so having milder turn in curve to the extent possible is always preferable in view of above as well as maintainability point of view.

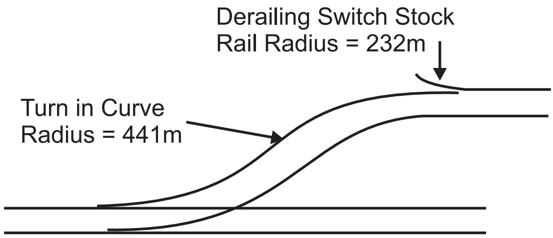


Fig. 7.5 Turn in curve

7.6.2 Turn in curves where main line is curved and loop line is inside: In such cases, turn in curve may have curvature in the same or opposite direction of the lead curve depending up on curvature of main line. In case of sharper curve on main line, turn in curve will be having curvature in the same direction, where as in case of mild curve (which are more likely in case of passenger running line), it may be in opposite direction. In case turn in curve is having flexure opposite to the lead curve it poses maximum problems (Fig. 7.6).

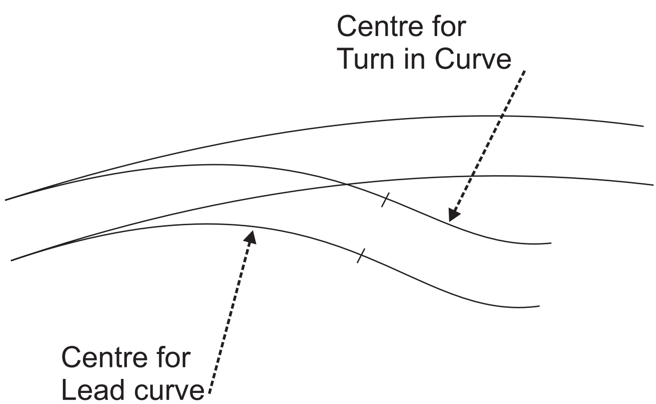


Fig. 7.6 Turn in curve after similar flexure

Because in this case, immediately after passing last long sleeper vehicle will run on negative super elevation, which will limit

maximum possible speed on turn in curve.
Let us calculate speed potential for one such turn in curve. Suppose main line curve is of 1.50, required super elevation on main line will be,

$$Ca + Cd = GV^2/127\,R_{main}$$
$$= 1750x120^2/127x1167$$
$$= 170mm$$

So, the super elevation on main line required is 95mm. However as per IRPWM para 414(2) in cases where **a similar flexure turnout is followed by a curve of reverse curve,** super elevation on turnout should be limited to 65mm. It may lead to imposition of speed restriction on main line. By layout calculation radius of turn in will be calculated as 1626m for track centre of 4725mm.

Speed restriction on main line (for super elevatim of 65mm)

$$= (127\,R_{main}\,(Ca + Cd) / G)^{½}$$
$$= (127 \times 1167 \times (65 + 75)/1750)^{½}$$
$$= 108.88kmph\ (say\ 105kmph)$$

However when the turnout is laid on super elevation of 65mm, turn in curve starts with a negative super elevation of 65mm. So the speed allowable on turn in curve

$$= (127 \times R_{turnin} \times\ (Ca + Cd) / 1750)^{½}$$
$$= (127 \times 1626 \times (-65 + 75) / 1750)^{½}$$
$$= 34.36kmph\ (say\ 30kmph),$$

so the speed which can be allowed on turnout side will be limited to 30kmph.

However, scenario changes when the turnout is laid on milder curve say 1.25^0 (radius1400m). By layout calculations, the radius of turn in curve comes out to 1110m in opposite direction. In such condition for main line,

$$Ca + Cd = GV^2/127\,R_{main}$$

$= 1750 \times 1202/127 \times 1400$

$= 141.73mm$

So the maximum super elevation for main line will be kept as 65mm, which will act as negative super elevation for turn in curve. Speed potential for turn in curve will be,

$= (127 \times R_{turnin} \times (Ca + Cd) / 1750)^{½}$

$= (127 \times 1110 \times (-65 + 75)/1750)^{½}$

$= 28.38kmph$ (say 25kmph)

So in this way, one can understand that the speed potential of turn in curve may reduce the speed potential of turnout / layout. **Hence, while increasing speed of train to 30kmph or more, speed potential of each and every turnout and every component of layout should be individually calculated. Speed on turnout can not be raised merely by changing turnout to curved thick web switches.**

7.6.3 Turn in curves where main line is curved and loop line is outside: In cases where main and loop line both are on curve and loop is on outside, turn in curve will have same flexure as that of main line. Hence no such special problems are encountered. In such cases the turn-out curve shall have the same cant as the main line curve.

7.7 Derailing switches: Derailing switches are provided on loop lines to isolate it from main line, so that if a vehicle standing on loop line escapes from loop and rolls down it will not infringe the main line, where train operation at full speed is going on. It consists of two stock rails and one tongue rail. One of the stock rail and the only tongue rail is provided a pre-curvature. RDSO has issued list of drawing of various derailing switches suitable to be laid on turrn-in-curve or straight as given in table 7.2. Derailing switches located in curve portion is shown in fig. 7.7. In this case it is better to select symmetrical split D/S so as to match with turn-in-curve radius, fig.7.8.

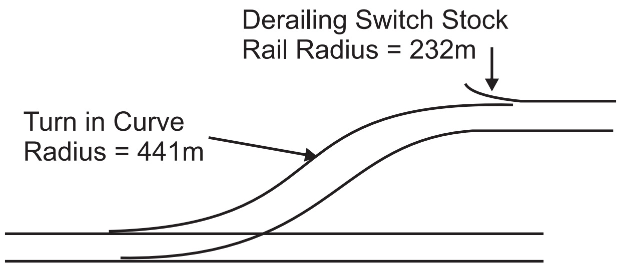


Fig. 7.7 Derailing switch

D/S can also be laid in straight if enough space for accommodation of derailing switch on straight is available.

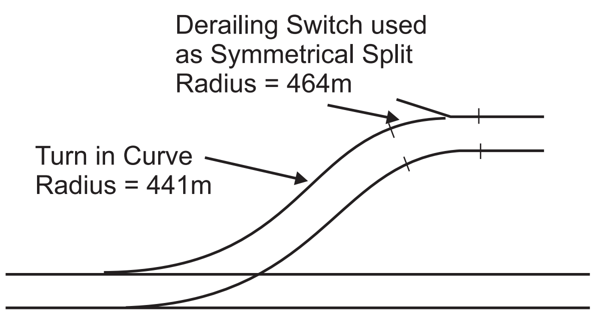


Fig. 7.8 Derailing switch as per RDSO/T-7078

For reference to field official following table for derailing switches and its location on loop line is being given as circulated by RDSO.

Table 7.2

S. No.	Drawing No.	Derailing Switch Drawing Description	location	Remarks
1	RDSO/T-8077	6400 Over-riding curved (Symmetrical Split Layout) derailing R.H. switch B.G(1673mm) for 60kg(UIC) on PSC Sleepers.	To be located at **turn-in curve.**	These are suitable for 30kmph & valid for LH curved Derailing Switch & RH Derailing Switch with use of special bearing plates as mentioned in respective drawings.
2	RDSO/T-8153	6400 Over-riding curved (Symmetrical Split Layout) derailing R.H. switch B.G (1673mm) for 52kg on PSC Sleepers.	To be located at **turn-in curve.**	
3	RDSO/T-8007	6400 Over-riding L.H derailing switch with straight tongue rail for B.G(1673mm) for 60kg(UIC) rail on PSC Sleepers.	To be located on straight portion of track at the end of **turn-in curve.**	
4	RDSO/T-8523	6400 Over-riding L.H derailing switch with straight tongue rail for B.G(1673mm) for 52kg rail on PSC Sleepers.		
5	RDSO/T-8089	10125mm Over-riding R.H derailing switch B.G(1673mm) for 60kg(UIC) rail on PSC Sleepers.	To be located at **turn-in curve.**	Tongue rail curved (R=441m)
6	RDSO/T-6068	6400mm Over-riding R.H derailing switch B.G(1673mm) for 60kg(UIC) rail on PSC Sleepers.	To be located at **turn-in curve.**	
7	RDSO/T-8522	10125mm Over-riding R.H derailing switch with Curved tongue rail for B.G(1673mm) for 52kg rail on PSC Sleepers.	To be located at **turn-in curve.**	

■ ■ ■

Annexure - 1

Table of Sleepers (1 in 12 T/out) (Ref. RDSO Drg.4218)

SLEEPER No.	DRAWING No.	LENGTH
60S	RDSO/T- 4786	2750
60-4A	RDSO/T- 4790	2750
60-3A	RDSO/T- 4789	2750
60-2AS	RDSO/T- 4788	2750
60-1AS	RDSO/T- 4787	2750
1	RDSO/T- 4512	2750
2	RDSO/T- 4512	2750
3	RDSO/T- 4514	3750
4	RDSO/T- 4515	3750
5	RDSO/T- 4516	2750
6	RDSO/T- 4517	2750
7	RDSO/T- 4518	2750
8	RDSO/T- 4519	2750
9	RDSO/T- 4520	2750
10	RDSO/T- 4521	2750
11	RDSO/T- 4522	2750
12	RDSO/T- 4523	2750
13	RDSO/T- 4524	2750
14	RDSO/T- 4525	2750
15	RDSO/T- 4526	2750
16	RDSO/T- 4527	2750
17	RDSO/T- 4528	2760
18	RDSO/T- 4529	2770
19	RDSO/T- 4530	2790
20	RDSO/T- 4531	2800
21	RDSO/T- 4532	2820
22	RDSO/T- 4533	2830
23	RDSO/T- 4534	2850
24	RDSO/T- 4535	2870
25	RDSO/T- 4536	2890
26	RDSO/T- 4537	2900
27	RDSO/T- 4538	2920
28	RDSO/T- 4539	2940
29	RDSO/T- 4540	2960
30	RDSO/T- 4541	2990
31	RDSO/T- 4542	3010
32	RDSO/T- 4543	3030
33	RDSO/T- 4544	3050
34	RDSO/T- 4545	3080
35	RDSO/T- 4546	3100
36	RDSO/T- 4547	3130
37	RDSO/T- 4548	3160
38	RDSO/T- 4549	3180
39	RDSO/T- 4550	3210
40	RDSO/T- 4551	3240
41	RDSO/T- 4552	3270
42	RDSO/T- 4553	3300
43	RDSO/T- 4554	3330
44	RDSO/T- 4555	3360
45	RDSO/T- 4556	3390
46	RDSO/T- 4557	3420
47	RDSO/T- 4558	3460
48	RDSO/T- 4559	3490
49	RDSO/T- 4560	3520
50	RDSO/T- 4561	3560
51	RDSO/T- 4562	3600
52	RDSO/T- 4563	3630
53	RDSO/T- 4564	3670
54	RDSO/T- 4565	3710
55	RDSO/T- 4566	3750
56	RDSO/T- 4567	3790
57	RDSO/T- 4568	3830
58	RDSO/T- 4569	3870
59	RDSO/T- 4570	3910
60	RDSO/T- 4571	3950
61	RDSO/T- 4572	3990
62	RDSO/T- 4573	4040
63	RDSO/T- 4574	4080
64	RDSO/T- 4575	4120
65	RDSO/T- 4576	4170
66	RDSO/T- 4577	4220
67	RDSO/T- 4578	4260
68	RDSO/T- 4579	4310
69	RDSO/T- 4580	4350
70	RDSO/T- 4581	4400
71	RDSO/T- 4582	4440
72	RDSO/T- 4583	4490
73	RDSO/T- 4584	4540
74	RDSO/T- 4585	4580
75	RDSO/T- 4586	4630
76	RDSO/T- 4587	4680
77	RDSO/T- 4588	4720
78	RDSO/T- 4589	4770
79	RDSO/T- 4590	4810
80	RDSO/T- 4591	4850
81	RDSO/T- 4592	4800
82	RDSO/T- 4593	4900
83	RDSO/T- 4594	4900
1E	RDSO/T- 5471	2550
2E	RDSO/T- 5472	2550
3E	RDSO/T- 5473	2550
4E	RDSO/T- 5474	2550

DETAILS OF FITTINGS FOR 1 IN 12, 60KG, FAN SHAPED TURNOUT ON PSC SLEEPERS

TABLE OF SLEEPERS & THEIR FITTING

1 in 12 T/Out- 60 Kg

Ref: RDSO's Drg 4219 with latest alteration dtd 2/11/2016

SLEEPER No.	SLEEPER TO DRG. No.	LENGTH (mm)	TIE PLATE ONE SET OF RDSO/T-5204 TO RDSO/T-5204/2 WITH FITTINGS	2 No. OF GRSP TO DRG. No.	24 DIA. PLATE SCREWS RDSO/T-3912	LINERS RDSO/T-3706	ELASTIC RAIL CLIPS RDSO/T-3701	SLIDE CHAIRS RDSO/T-4596	SINGLE COIL SPRING WASHER T-10773	M.S. PLATE RDSO/T-3901
1 & 2	RDSO/T-4512	2750	-	RDSO/T-8295	2	4	4	-	2	-
3	RDSO/T-4514	3750	ONE SET	RDSO/T-4610 & RDSO/T-3907	14	-	-	-	14	-
4	RDSO/T-4515	3750	-	-do-	12	-	-	2	12	1
5	RDSO/T-4516	2750	-	RDSO/T-4610	8	-	-	2	8	-
6	RDSO/T-4517	2750	-	RDSO/T-4610	8	-	-	2	8	-
7	RDSO/T-4518	2750	-	RDSO/T-4610	8	-	-	2	8	-
8	RDSO/T-4519	2750	-	RDSO/T-4610	8	-	-	2	8	-
9	RDSO/T-4520	2750	-	RDSO/T-4610	8	-	-	2	8	-
10	RDSO/T-4521	2750	-	RDSO/T-4610	8	-	-	2	8	-
11	RDSO/T-4522	2750	-	RDSO/T-4610	8	-	-	2	8	-
12	RDSO/T-4523	2750	-	RDSO/T-4610	8	-	-	2	8	-
13	RDSO/T-4524	2750	-	RDSO/T-4610	8	-	-	2	8	-
14	RDSO/T-4525	2750	-	RDSO/T-4610	8	-	-	2	8	-
15	RDSO/T-4526	2750	-	RDSO/T-4610	8	-	-	2	8	-
16	RDSO/T-4527	2750	-	RDSO/T-4610	8	-	-	2	8	-
17	RDSO/T-4528	2760	-	RDSO/T-4610	8	-		2	8	-
18	RDSO/T-4529	2770	-	RDSO/T-4610	8	-	-	2	8	-
19	RDSO/T-4530	2790	-	RDSO/T-4610	8	-	-	2	8	-
20	RDSO/T-4531	2800	-	RDSO/T-4610	8	-	-	2	8	-

TABLE OF SLEEPERS & THEIR FITTING

1 in 12 T/Out- 60 Kg

Ref: RDSO's Drg 4219 with latest alteration dtd 2/11/2016

SLEEPER No.	SLEEPER TO DRG. No.	LENGTH (mm)	SPECIAL FLAT BEARING PLATE TO DRG. No.		2 No. GRSP TO DRG. No.	24 DIA. PLATE SCREWS TO DRG. No. RDSO/T-3912	INSULA-TING LINERS RDSO/T-3706	ELASTICK RAIL CLIPS RDSO/T-3701	SINGLE COIL SPRING WASHER T-10773	GROOVED RUBBER SOLE PLATE RDSO/T-4614
			RIGHT	LEFT						
21	RDSO/T-4532	2820	RDSO/T-4597	RDSO/T-4597	RDSO/T-4611	8	2	2	8	2
22	RDSO/T-4533	2830	RDSO/T-4598	RDSO/T-4604	RDSO/T-4612	8	4	4	8	4
23	RDSO/T-4534	2850	RDSO/T-4599	RDSO/T-4605	RDSO/T-4612	8	4	4	8	4
24	RDSO/T-4535	2870	RDSO/T-4600	RDSO/T-4606	RDSO/T-4612	8	4	4	8	4
25	RDSO/T-4536	2890	RDSO/T-8314	RDSO/T-4607	RDSO/T-4613	8	4	4	8	4
26	RDSO/T-4537	2900	RDSO/T-8315	RDSO/T-4608	RDSO/T-4613	8	4	4	8	4
27	RDSO/T-4538	2920	RDSO/T-8316	RDSO/T-4609	RDSO/T-4613	8	4	4	8	4

TABLE OF SLEEPERS AND THEIR FITTINGS

1 in 12 T/Out- CMS Xing/ 60 Kg

Ref: RDSO's Drg 4220 with latest alteration dtd 2/11/2016

SLEEPER Nº	DRAWING Nº	GROOVED RUBBER SOLE PLATE														INSULATING LINERS	ERC
		RDSO/T-6204	RDSO/T-6205	RDSO/T-6206	RDSO/T-6207	RDSO/T-6208	RDSO/T-6209	RDSO/T-6210	RDSO/T-6211	RDSO/T-6843	RDSO/T-6844	RDSO/T-6845	RDSO/T-6846	RDSO/T-8292	RDSO/T-8294	RDSO/T-3706	RDSO/T-3701
65	RDSO/T-4576	–	–	–	–	–	–	–	–	–	–	1	–	–	2	6	6
66	RDSO/T-4577	1	–	–	–	–	–	–	–	–	–	–	–	–	2	6	6
67	RDSO/T-4578	–	1	–	–	–	–	–	–	–	–	–	–	–	2	6	6
68	RDSO/T-4579	–	–	1	–	–	–	–	–	–	–	–	–	–	2	6	6
69	RDSO/T-4580	–	–	–	1	–	–	–	–	–	–	–	–	–	2	6	6
70	RDSO/T-4581	–	–	–	–	1	–	–	–	–	–	–	–	–	2	6	6
71	RDSO/T-4582	–	–	–	–	–	1	–	–	–	–	–	–	–	2	6	6
72	RDSO/T-4583	–	–	–	–	–	–	1	–	–	–	–	–	–	2	6	6
73	RDSO/T-4584	–	–	–	–	–	–	–	1	–	–	–	–	2	–	6	6
74	RDSO/T-4585	–	–	–	–	–	–	–	–	–	–	–	1	2	–	6	6
75	RDSO/T-4586	–	–	–	–	–	–	–	–	1	–	–	–	2	–	7	7
76	RDSO/T-4587	–	–	–	–	–	–	–	–	–	1	–	–	2	–	7	7
77	RDSO/T-4588	–	–	–	–	–	–	–	–	–	–	–	–	4	–	8	8
78	RDSO/T-4589	–	–	–	–	–	–	–	–	–	–	–	–	4	–	8	8
79	RDSO/T-4590	–	–	–	–	–	–	–	–	–	–	–	–	4	–	8	8
80	RDSO/T-4591	–	–	–	–	–	–	–	–	–	–	–	–	4	–	8	8
81	RDSO/T-4592	–	–	–	–	–	–	–	–	–	–	–	–	4	–	8	8
82	RDSO/T-4593	–	–	–	–	–	–	–	–	–	–	–	–	4	–	8	8
83	RDSO/T-4594	–	–	–	–	–	–	–	–	–	–	–	–	4	–	8	8

TABLE OF FITTINGS

1 in 12 T/Out- 60 Kg

Ref: RDSO's Drg 4218 with latest alteration dtd 2/11/2016

SLEEPER No.	GRSP			INSULATING LINER RDSO/T-3706	ERC RDSO/T-3701	M.S. PLATE RDSO/T-3902	PLATE SCREW RDSO/T- 3912
	RDSO/T-8295	RDSO/T-8292	RDSO/T-6842				
APPROACH PORTION:							
60 S	2	---	---	4	4	1	6
60-4A	2	---	---	4	4	1	6
60-3A	2	---	---	4	4	1	6
60-2AS	2	---	---	4	4	1	6
60-1AS	2	---	---	4	4	1	6
SWITCH PORTION: PLEASE REFER DRG. No. RDSO/T- 4219							
LEAD PORTION:							
28 TO 63	---	140	---	280	280	---	---
64	---	2	1	7	7	---	---
CROSSING PORTION: PLEASE REFER DRG. No. RDSO/T- 4220							
EXIT PORTION:							
1 E X 2	4	---	---	8	8	---	---
2 E X 2	4	---	---	8	8	---	---
3 E X 2	4	---	---	8	8	---	---
4 E X 2	4	---	---	8	8	---	---

1 in 12 T/Out- 60 Kg

Ref: RDSO's Drg 4219 with latest alteration dtd 2/11/2016

PART	DESCRIPTION	No. OFF
RDSO/T-4018	CHECK RAILS	2
RDSO/T-4711	M.S. FLAT TIE BAR	2
RDSO/T-3907	GROOVED RUBBER SOLE PLATES	4
T-11690	BLACK BOLTS	3
RDSO/T-3901	M.S. PLATES	1
RDSO/T-1292	INSULATING BUSH	3
RDSO/T-1291	INSULATING PLATE	1
RDSO/T-8295	GROOVED RUBBER SOLE PLATES	4
RDSO/T-4614	GROOVED RUBBER SOLE PLATES	26
RDSO/T-4613	GROOVED RUBBER SOLE PLATES	6
RDSO/T-4612	GROOVED RUBBER SOLE PLATES	6
RDSO/T-4611	GROOVED RUBBER SOLE PLATES	2
RDSO/T-4610	GROOVED RUBBER SOLE PLATES	36
T-11637	BOLTS 18X90	16
T-11635	TURNED BOLTS 18X80	16
T-11634	TURNED BOLTS 18X75	4
T-11533	BOLTS 25X380	2
T-11531	BOLTS 25X360	2
T-11526	BOLTS 25X310	2
T-11523	BOLTS 25X280	2
T-11522	BOLTS 25X270	2
T-11508	BOLTS 25X130	14
T-11504	BOLTS (22 mm TH. BOLT HEAD) 25X90	2
T-11504	BOLTS (8 mm TH. BOLT HEAD) 25X90	22+10* =32
RDSO/T-3706	INSULATING LINERS	34
RDSO/T-3701	ELASTIC RAIL CLIP MK - III	34
RDSO/T-4597	SPECIAL BEARING PLATE	2
RDSO/T-8314 TO RDSO/T-8316	BEARING PLATES	ONE EACH
RDSO/T-4604 TO RDSO/T-4609	BEARING PLATES	ONE EACH
RDSO/T-4598 TO RDSO/T-4600	BEARING PLATES	ONE EACH
RDSO/T-3912	PLATE SCREWS	218
T-10773	SINGLE COIL SPRING WASHERS	280
T-10371	INSULATING WASHERS	6
RDSO/T-5204 TO RDSO/T-5204/2	TIE PLATES	ONE SET
T-083(M)	LUGS	2
T-023(M)	SPHERICAL WASHERS	10
RDSO/T-1899	FISH BOLTS	12
RDSO/T-5916	FISH PLATE	4
RDSO/T-2625	M.S. BRACKET	8
RDSO/T-4596	SLIDE CHAIRS	34

Contd on next page

1 in 12 T/Out- 60 Kg

Ref: RDSO's Drg 4219 with latest alteration dtd 2/11/2016

PART	DESCRIPTION	No. OFF
RDSO/T-3655 & RDSO/T-3656	3rd FOLLOWING STRETCHER BAR (INSULATED)	ONE SET
RDSO/T-3653 & RDSO/T-3654	2nd FOLLOWING STRETCHER BAR (INSULATED)	ONE SET
RDSO/T-3651 & RDSO/T-3652	1st FOLLOWING STRETCHER BAR (INSULATED)	ONE SET
RDSO/T-3649 & RDSO/T-3650	LEADING STRETCHER BAR (INSULATED)	ONE SET
RDSO/T-4347 TO RDSO/T--4358	SLIDE BLOCKS	ONE EACH
RDSO/T-4359	DISTANCE BLOCKS	2
RDSO/T-4360	DISTANCE BLOCKS	2
RDSO/T-2612	DISTANCE BLOCKS	2
RDSO/T-2611	HEEL BLOCKS	2
RDSO/T-2610	REINFORCING STRAPS LH	2
RDSO/T-2610	REINFORCING STRAPS RH	2
RDSO/T-4325/1	TONGUE RAIL LEFT	1
RDSO/T-4325/1	TONGUE RAIL RIGHT	1
RDSO/T-4325/1	STOCK RAIL LEFT	1
RDSO/T-4325/1	STOCK RAIL RIGHT	1

1 in 12 T/Out- CMS Xing/ 60 Kg

Ref: RDSO's Drg 4220 with latest alteration dtd 2/11/2016

PART.	DESCRIPTION	No OFF
RDSO/T-5916	FISH PLATES	4
RDSO/T-1898	FISHPLATES	4
RDSO/T-1899	FISHBOLTS	8
T- 11535	BOLT 25X400	1
T- 11533	BOLT 25X380	1
T- 11532	BOLT 25X370	1
T- 11531	BOLT 25X360	2
T- 11529	BOLT 25X340	2
T- 11528	BOLT 25X330	2
T- 11527	BOLT 25X320	1
T- 11525	BOLT 25X300	1
T- 11524	BOLT 25X290	1
T- 11514	BOLT 25X190	8
T- 10773	SINGLE COIL SPRING WASHER	28
RDSO/T-8294	GROOVED RUBBER SOLE PLATE	16
RDSO/T-8292	GROOVED RUBBER SOLE PLATE	36
RDSO/T-6846	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6845	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6844	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6843	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6211	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6210	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6209	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6208	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6207	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6206	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6205	GROOVED RUBBER SOLE PLATE	1
RDSO/T-6204	GROOVED RUBBER SOLE PLATE	1
RDSO/T-4121	C.I. DISTANCE BLOCK	1
RDSO/T-2716	C.I. DISTANCE BLOCK	1
T- 026(M)	PACKING PIECES	16
RDSO/T-3930	M.S. TAPERED WASHERS	24
RDSO/T-3706	INSULATING LINERS	130
RDSO/T-3701	ELASTIC RAIL CLIPS	130
RDSO/T-2592	CHECK RAIL BLOCKS	8
RDSO/T-4018	CHECK RAILS	2
RDSO/T-3940/1	CMS CROSSING	1

1 in 12 T/Out- 60 Kg

Ref: RDSO's Drg 4218 with latest alteration dtd 2/11/2016

PART	DESCRIPTION	No. OFF
T 10773	SINGLE COIL SPRING WASHERS	36
RDSO/T-3912	PLATE SCREWS	36
RDSO/T-3902	M.S. PLATE	5
RDSO/T-5471	EXIT SLEEPER No. 1E	2
RDSO/T-5472	EXIT SLEEPER No. 2E	2
RDSO/T-5473	EXIT SLEEPER No. 3E	2
RDSO/T-5474	EXIT SLEEPER No. 4E	2
RDSO/T-4790	APPROACH SLEEPER No. 60 - 4A	1
RDSO/T-4789	APPROACH SLEEPER No. 60 - 3A	1
RDSO/T-4788	APPROACH SLEEPER No. 60 - 2AS	1
RDSO/T-4787	APPROACH SLEEPER No. 60 - 1AS	1
RDSO/T-4786	APPROACH SLEEPER No. 60S	1
RDSO/T-3701	ELASTIC RAIL CLIPS	347
RDSO/T-3706	INSULATING LINERS	347
RDSO/T-6842	GROOVED RUBBER SOLE PLATES	1
RDSO/T-8295	GROOVED RUBBER SOLE PLATES	26
RDSO/T-8292	GROOVED RUBBER SOLE PLATES	146
	22052 mm LONG RAIL 60 Kg. (UIC)	1
	22100 mm LONG RAIL 60 Kg. (UIC)	1
	26884 mm LONG RAIL 60 Kg. (UIC)	1
	26975 mm LONG RAIL 60 Kg. (UIC)	1

Other special & miscellaneous items for fan shaped turnout

1. Over riding switch L & R complete sets RT-4219 & RT-4325/1 details: Switch length = 10125mm, length of Tongue rail = 12356 mm, stock rail length = 13000mm switch angle $0^0$20'0" Hd = 175mm.
2. CMS crossing 1 in 12, 60 kg. drg. No. RT-4220 length=4350mm, angle 4^0 45'49".
3. Check rails 60 kg., drg. No.RT-4018=2 nos., length = 4330 mm, check blocks T-2592 = 8 nos. with bolts and nuts T-11514 & packing pieces T-026 (M).
4. Total no. of Fish plate required = 12 of T-1898 and 4 of T-5916
5. Overall length of turnout = 39975mm, rails required (1) 22052mm (2) 22100mm (3) 26884mm, (4) 26975mm one each in lead position.

Notes

1. Same set of sleepers from 1 to 83 and approach sleepers can be used in RH and LH turnouts by mutual interchanging of sleeper spacing on outer and inner rails.
2. Sleeper No. 1 to 20 are perpendicular to main line, 21 to 64 are laid Fan Shaped i.e. their spacing are different at RH & LH gauge faces of straight track, sleeper no. 65 to 83 are laid perpendicular to center line of crossing, spacing are measured at gauge faces of L & R rail of main line track.
3. Single coil spring washer T-10773 shall be used with all 25mm dia bolts.
4. Three bolts are provided at either end of fish plated joint of CMS crossings
5. Metal liner RT-3738 will be used in place of GFN RT-3706 in Non track circuited areas.
6. Every PSC sleeper has got RE engraved at right end and should be laid irrespective of LH/RH Turnout.

Annexure - 2

DETAILS OF FITTINGS FOR 1 IN 12, 52KG, FANSHAPED TURNOUT ON PSC SLEEPERS

Ref: RDSO's Drawing no T-4733 with latest alteration dtd. 27/2/2017

PART	DESCRIPTION	No. OFF
RDSO/T-4773	CHECK RAILS	2
T-11690	BLACK BOLTS 18X90	8
RDSO/T-4711	M.S. FLAT TIE BAR	2
RDSO/T-3901	M.S. PLATES	1
RDSO/T-3907	GROOVED RUBBER SOLE PLATES	4
RDSO/T-4722	GROOVED RUBBER SOLE PLATES	26
RDSO/T-8295	GROOVED RUBBER SOLE PLATES	4
RDSO/T-4613	GROOVED RUBBER SOLE PLATES	6
RDSO/T-4612	GROOVED RUBBER SOLE PLATES	6
RDSO/T-4611	GROOVED RUBBER SOLE PLATES	2
RDSO/T-4610	GROOVED RUBBER SOLE PLATES	36
T-11637	BOLTS CUT HEAD 18X90	16
T-11635	TURNED BOLTS 18X80	16
T-11634	TURNED BOLTS 18X75	4
T-11533	BOLTS 25X380	2
T-11531	BOLTS 25X360	2
T-11525	BOLTS 25X300	2
T-11523	BOLTS 25X280	2
T-11522	BOLTS 25X270	2
T-11508	BOLTS 25X130	10
T-11504	BOLTS (22 mm THICK BOLT HEAD) 25X90	4
T-11504	BOLTS (8 mm THICK BOLT HEAD) 25X90	22+10* =32
RDSO/T-3702	INSULATING LINERS	30
RDSO/T-3708	INSULATING LINERS	4
RDSO/T-3707	INSULATING LINERS	4
RDSO/T-3701	ELASTIC RAIL CLIP MK - III	38
RDSO/T-4736	SPECIAL BEARING PLATES	2
RDSO/T-4737 TO RDSO/T-4738	SPECIAL BEARING PLATES	ONE EACH
RDSO/T-8016 TO RDSO/T-8019	SPECIAL BEARING PLATES	ONE EACH
RDSO/T-4743 TO RDSO/T-4748	SPECIAL BEARING PLATES	ONE EACH
RDSO/T-3912	PLATE SCREWS	218

Contd on next page

PART	DESCRIPTION	No. OFF
RDSO/T-3912	PLATE SCREWS	218
T-10773	SINGLE COIL SPRING WASHERS	272
RDSO/T-5203 TO RDSO/T-5203/2	EXTENDED TIE PLATES	ONE SET
T-083(M)	LUGS	2
T-023(M)	SPHERICAL WASHERS	10
RDSO/T-11509	FISH BOLTS	12
RDSO/T-5915	FISH PLATES	4
T- 263 (M)/A	M.S. BRACKET	8
RDSO/T-4735	SLIDE CHAIRS	34
RDSO/T-4770 & RDSO/T-4771	3rd FOLLOWING STRETCHER BAR (INSULATED)	ONE SET
RDSO/T-4768 & RDSO/T-4769	2nd FOLLOWING STRETCHER BAR (INSULATED)	ONE SET
RDSO/T-4766 & RDSO/T-4767	1st FOLLOWING STRETCHER BAR (INSULATED)	ONE SET
RDSO/T-4764 & RDSO/T-4765	LEADING STRETCHER BAR (INSULATED)	ONE SET
RDSO/T-4750 TO RDSO/T--4759	SLIDE BLOCKS	ONE EACH
RDSO/T-4763	DISTANCE BLOCKS	2
RDSO/T-4762	DISTANCE BLOCKS	2
RDSO/T-4761	DISTANCE BLOCKS	2
RDSO/T-4760	HEEL BLOCKS	2
RDSO/T-4772	REINFORCING STRAPS LH	2
RDSO/T-4772	REINFORCING STRAPS RH	2
RDSO/T-4733/1	TONGUE RAIL LEFT	1
RDSO/T-4733/1	TONGUE RAIL RIGHT	1
RDSO/T-4733/1	STOCK RAIL LEFT	1
RDSO/T-4733/1	STOCK RAIL RIGHT	1

1 in 12 T/out- 52 Kg/ CMS xing

Ref: RDSO's Drawing no T-4734 with latest alteration dtd. 27/2/2017

PART	DESCRIPTION	No. OFF
T- 026 (M)	PACKING PIECES	16
RDSO/T- 3930	M.S. TAPERED WASHERS	24
RDSO/T- 5915	FISH PLATES	4
T- 090 (M)	FISH PLATES	4
T- 11501	FISH BOLTS (25X130)	8
T- 11534	BOLT 25X390	1
T- 11532	BOLT 25X370	1
T- 11531	BOLT 25X360	2
T- 11530	BOLT 25X350	2
T- 11528	BOLT 25X330	2
T- 11527	BOLT 25X320	2
T- 11525	BOLT 25X300	1
T- 11524	BOLT 25X290	1
T- 11513	BOLT 25X180	8
T- 10773	SINGLE COIL SPRING WASHER	28
RDSO/T- 8294	GROOVED RUBBER SOLE PLATE	16
RDSO/T- 8292	GROOVED RUBBER SOLE PLATE	36
RDSO/T- 6846	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6845	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6844	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6843	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6842	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6211	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6210	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6209	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6208	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6207	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6206	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6205	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 6204	GROOVED RUBBER SOLE PLATE	1
RDSO/T- 4776	C.I. DISTANCE BLOCK	1
RDSO/T- 4775	C.I. DISTANCE BLOCK	1
RDSO/T- 3708	INSULATING LINERS	76
RDSO/T- 3707	INSULATING LINERS	44
RDSO/T- 3702	INSULATING LINERS	16
RDSO/T- 3701	ELASTIC RAIL CLIPS	136
RDSO/T- 4774	CHECK RAIL BLOCKS	8
RDSO/T- 4773	CHECK RAIL	2
RDSO/T- 4734/1	CMS CROSSING	1

Ref: RDSO's Drawing no T-4732 with latest alteration dtd. 27/2/2017

1 in 12 T/Out (for 52 Kg)

PART	DESCRIPTION	NO. OFF
T 10773	SINGLE COIL SPRING WASHERS	18
RDSO/T- 3912	PLATE SCREWS	18
RDSO/T- 3902	M.S. PLATE	3
RDSO/T- 5471	EXIT SLEEPER No. 1E	2
RDSO/T- 5472	EXIT SLEEPER No. 2E	2
RDSO/T- 5473	EXIT SLEEPER No. 3E	2
RDSO/T- 5474	EXIT SLEEPER No. 4E	2
RDSO/T- 4790	APPROACH SLEEPER No. 60 - 4A	1
RDSO/T- 4789	APPROACH SLEEPER No. 60 - 3A	1
RDSO/T- 4788	APPROACH SLEEPER No. 60 - 2AS	1
RDSO/T- 4787	APPROACH SLEEPER No. 60 - 1AS	1
RDSO/T- 4786	APPROACH SLEEPER No. 60S	1
RDSO/T- 3701	ELASTIC RAIL CLIPS	340
RDSO/T- 3707	INSULATING LINERS	170
RDSO/T- 3708	INSULATING LINERS	170
RDSO/T- 8295	GROOVED RUBBER SOLE PLATES	26
RDSO/T- 8292	GROOVED RUBBER SOLE PLATES	144
	22052 mm LONG RAIL 52 Kg.	1
	22100 mm LONG RAIL 52 Kg.	1
	26884 mm LONG RAIL 52 Kg.	1
	26975 mm LONG RAIL 52 Kg.	1

TABLE OF SLEEPERS & THEIR FITTINGS

1 in 12 T/out- 52 Kg

Ref: RDSO's Drawing no T-4733 with latest alteration dtd. 27/2/2017

SLEEPER No.	SLEEPER TO DRG. No.	TIE PLATE ONE SET OF RDSO/T-5203 TO RDSO/T-5203/2 WITH FITTINGS	2 Nos. OF GRSP TO DRG. No.	24 DIA. PLATE SCREWS RDSO/T-3912	INSULATING LINERS		ELASTICK RAIL CLIPS RDSO/T-3701	SLIDE CHAIRS RDSO/T-4735	SINGLE COIL SPRING WASHER T-10773	M.S. PLATE RDSO/T-3901
					RDSO/T-3707	RDSO/T-3708				
1 & 2	RDSO/T-4512	-	RDSO/T-8295	2	2	2	4	-	2	-
3	RDSO/T-4514	ONE SET	RDSO/T-4610 & RDSO/T-3907	14	-	-	-	-	14	-
4	RDSO/T-4515	-	-do-	12	-	-	-	2	12	1
5	RDSO/T-4516	-	RDSO/T-4610	8	-	-	-	2	8	-
6	RDSO/T-4517	-	RDSO/T-4610	8	-	-	-	2	8	-
7	RDSO/T-4518	-	RDSO/T-4610	8	-	-	-	2	8	-
8	RDSO/T-4519	-	RDSO/T-4610	8	-	-	-	2	8	-
9	RDSO/T-4520	-	RDSO/T-4610	8	-	-	-	2	8	-
10	RDSO/T-4521	-	RDSO/T-4610	8	-	-	-	2	8	-
11	RDSO/T-4522	-	RDSO/T-4610	8	-	-	-	2	8	-
12	RDSO/T-4523	-	RDSO/T-4610	8	-	-	-	2	8	-
13	RDSO/T-4524	-	RDSO/T-4610	8	-	-	-	2	8	-
14	RDSO/T-4525	-	RDSO/T-4610	8	-	-	-	2	8	-
15	RDSO/T-4526	-	RDSO/T-4610	8	-	-	-	2	8	-
16	RDSO/T-4527	-	RDSO/T-4610	8	-	-	-	2	8	-
17	RDSO/T-4528	-	RDSO/T-4610	8	-	-		2	8	-
18	RDSO/T-4529	-	RDSO/T-4610	8	-	-	-	2	8	-
19	RDSO/T-4530	-	RDSO/T-4610	8	-	-	-	2	8	-
20	RDSO/T-4531	-	RDSO/T-4610	8	-	-	-	2	8	-

1 in 12 T/out- 52 Kg

Ref: RDSO's Drawing no T-4733 with latest alteration dtd. ***27/2/2017***

SLEEPER No.	SLEEPER TO DRG. No.	SPECIAL FLAT BEARING PLATE TO DRG. No.		2 Nos. GRSP TO DRG. No.	24 DIA. PLATE SCREWS TO DRG. No. RDSO/T-3912	INSULA-TING LINERS RDSO/T-3702	ELASTIC RAIL CLIPS RDSO/T-3701	SINGLE COIL SPRING WASHER T-10773	GROOVED RUBBER SOLE PLATE RDSO/T-4722
		RIGHT	LEFT						
21	RDSO/T-4532	RDSO/T-4736	RDSO/T-4736	RDSO/T-4611	8	2	2	8	2
22	RDSO/T-4533	RDSO/T-4737	RDSO/T-4743	RDSO/T-4612	8	4	4	8	4
23	RDSO/T-4534	RDSO/T-4738	RDSO/T-4744	RDSO/T-4612	8	4	4	8	4
24	RDSO/T-4535	RDSO/T-8016	RDSO/T-4745	RDSO/T-4612	8	5	5	8	4
25	RDSO/T-4536	RDSO/T-8017	RDSO/T-4746	RDSO/T-4613	8	5	5	8	4
26	RDSO/T-4537	RDSO/T-8018	RDSO/T-4747	RDSO/T-4613	8	5	5	8	4
27	RDSO/T-4538	RDSO/T-8019	RDSO/T-4748	RDSO/T-4613	8	5	5	8	4

Ref: RDSO's Drawing no T-4732 with latest alteration dtd. 27/2/2017

SLEEPER No.	GRSP		INSULATING LINER		ERC	M.S. PLATE	PLATE SCREW
	RDSO/T-8295	RDSO/T-8292	RDSO/T-3707	RDSO/T-3708	RDSO/T-3701	RDSO/T-3902	RDSO/T- 3912
APPROACH PORTION:							
60 S	2	---	2	2	4	1	6
60-4A	2	---	2	2	4	---	---
60-3A	2	---	2	2	4	---	---
60-2AS	2	---	2	2	4	1	6
60-1AS	2	---	2	2	4	1	6
SWITCH PORTION: PLEASE REFER DRG. No. RDSO/T- 4733							
LEAD PORTION:							
28 TO 63	---	144	144	144	288	---	---
CROSSING PORTION: PLEASE REFER DRG. No. RDSO/T- 4734							
EXIT PORTION:							
1 E X 2	4	---	4	4	8	---	---
2 E X 2	4	---	4	4	8	---	---
3 E X 2	4	---	4	4	8	---	---
4 E X 2	4	---	4	4	8	---	---

1 in 12 T/out- 52 Kg/ CMS xing

Ref: RDSO's Drawing no T-4734 with latest alteration dtd. 27/2/2017

SLEEPER No.	DRAWING No.	GROOVED RUBBER SOLE PLATE															INSULATING LINERS			ERC
		RDSO/T-6204	RDSO/T-6205	RDSO/T-6206	RDSO/T-6207	RDSO/T-6208	RDSO/T-6209	RDSO/T-6210	RDSO/T-6211	RDSO/T-6842	RDSO/T-6843	RDSO/T-6844	RDSO/T-6845	RDSO/T-6846	RDSO/T-8292	RDSO/T-8294	RDSO/T-3702	RDSO/T-3707	**RDSO/T-3708**	**RDSO/T-3701**
64	RDSO/T- 4575	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	2	4	6
65	RDSO/T- 4576	--	--	--	--	--	--	--	--	--	--	--	1	--	--	2	--	--	6	6
66	RDSO/T- 4577	1	--	--	--	--	--	--	--	--	--	--	--	--	--	2	2	--	4	6
67	RDSO/T- 4578	--	1	--	--	--	--	--	--	--	--	--	--	--	--	2	2	--	4	6
68	RDSO/T- 4579	--	--	1	--	--	--	--	--	--	--	--	--	--	--	2	2	--	4	6
69	RDSO/T- 4580	--	--	--	1	--	--	--	--	--	--	--	--	--	--	2	2	--	4	6
70	RDSO/T- 4581	--	--	--	--	1	--	--	--	--	--	--	--	--	--	2	2	--	4	6
71	RDSO/T- 4582	--	--	--	--	--	1	--	--	--	--	--	--	--	--	2	2	--	4	6
72	RDSO/T- 4583	--	--	--	--	--	--	1	--	--	--	--	--	--	--	2	2	--	4	6
73	RDSO/T- 4584	--	--	--	--	--	--	--	1	--	--	--	--	--	2	--	2	2	2	6
74	RDSO/T- 4585	--	--	--	--	--	--	--	--	--	--	--	--	1	2	--	--	4	2	6
75	RDSO/T- 4586	--	--	--	--	--	--	--	--	--	1	--	--	--	2	--	--	4	3	7
76	RDSO/T- 4587	--	--	--	--	--	--	--	--	--	--	1	--	--	2	--	--	4	3	7
77	RDSO/T- 4588	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	4	4	8
78	RDSO/T- 4589	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	4	4	8
79	RDSO/T- 4590	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	4	4	8
80	RDSO/T- 4591	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	4	4	8
81	RDSO/T- 4592	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	4	4	8
82	RDSO/T- 4593	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	4	4	8
83	RDSO/T- 4594	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	4	4	8

Other special & miscellaneous items for fan shaped turnout

1	Over riding switch L&R complete sets RT-4219 & RT-4733 details: Switch length = 10125mm, length of Tongue rail = 12356 mm, stock rail length = 13000mm, switch angle $0^0$20'0" Hd = 175mm, radius R=441360mm, G=1673mm, Throw of switch=115mm.
2	CMS crossing 1 in 12, 52 kg. drg. no. RT-4734, length=4350mm, angle 4^0 45'49".
3	Check rails 52 kg., drg. No.RT-4773 = 2 nos. length = 4330mm, check blocks RT-4774 = 8 nos. with Bolts and nuts T-11513 & packing pieces T-026 (M).
4	Total No. of Fish plate required = 12 of T-090(M) and 4 of RT-5915
5	Overall length of turnout = 39975mm, rails required (1) 22502mm (2) 22100mm (3) 26884mm, (4) 26975mm one each in lead position.

Notes

1	Same set of sleepers from 1 to 83 and approach sleepers can be used in RH and LH turnouts by mutual interchanging of sleeper spacing on outer and inner rails.
2	Sleeper No. 1 to 20 are perpendicular to main line, 21 to 64 are laid Fan Shaped i.e. their spacing are different at RH & LH gauge faces of straight track, sleeper no.65 to 83 are laid perpendicular to center line of crossing, spacing are measured at gauge faces of L&R rail of main line track.
3	Single coil spring washer T-10772 shall be used with all 25mm dia bolts and all plate screws T-3912.
4	Three bolts are provided at either end of fish plated joint of CMS crossings.
5	Metal liner RT-3738, RT-3741 and RT-3742 will be used in place of GFN liner RT-3702, RT-3707 and RT-3708 respectively in non-track circuited areas.
6.	Every PSC sleeper has got RE engraved at right end and should be laid irrespective of LH/RH Turnout.

ANNEXURE 3

DETAILS OF FITTINGS FOR 1 IN 8.5, 60KG/52KG, FANSHAPED TURNOUT ON PSC SLEEPERS

Table of Sleepers (1 in 8.5 T/out

SLEEPER No.	DRAWING No.	LENGTH
60S	RDSO/T- 4786	2750
60-4A	RDSO/T- 4790	2750
60-3A	RDSO/T- 4789	2750
60-2AS	RDSO/T- 4788	2750
60-1AS	RDSO/T- 4787	2750
1	RDSO/T- 4791	2750
2	RDSO/T- 4791	2750
3	RDSO/T- 4793	3750
4	RDSO/T- 4794	3750
5	RDSO/T- 4795	2750
6	RDSO/T- 4796	2750
7	RDSO/T- 4797	2750
8	RDSO/T- 4798	2750
9	RDSO/T- 4799	2750
10	RDSO/T- 4800	2750
11	RDSO/T- 4801	2770
12	RDSO/T- 4802	2790
13	RDSO/T- 4803	2820
14	RDSO/T- 4804	2840
15	RDSO/T- 4805	2870
16	RDSO/T- 4806	2900
17	RDSO/T- 4807	2930
18	RDSO/T- 4808	2960
19	RDSO/T- 4809	2990
20	RDSO/T- 4810	3020
21	RDSO/T- 4811	3060
22	RDSO/T- 4812	3100
23	RDSO/T- 4813	3130
24	RDSO/T- 4814	3180
25	RDSO/T- 4815	3220
26	RDSO/T- 4816	3260
27	RDSO/T- 4817	3310

SLEEPER No.	DRAWING No.	LENGTH
28	RDSO/T- 4818	3350
29	RDSO/T- 4819	3400
30	RDSO/T- 4820	3450
31	RDSO/T- 4821	3500
32	RDSO/T- 4822	3550
33	RDSO/T- 4823	3610
34	RDSO/T- 4824	3660
35	RDSO/T- 4825	3720
36	RDSO/T- 4826	3780
37	RDSO/T- 4827	3840
38	RDSO/T- 4828	3900
39	RDSO/T- 4829	3970
40	RDSO/T- 4830	4030
41	RDSO/T- 4831	4100
42	RDSO/T- 4832	4170
43	RDSO/T- 4833	4230
44	RDSO/T- 4834	4290
45	RDSO/T- 4835	4350
46	RDSO/T- 4836	4430
47	RDSO/T- 4837	4490
48	RDSO/T- 4838	4550
49	RDSO/T- 4839	4620
50	RDSO/T- 4840	4690
51	RDSO/T- 4841	4750
52	RDSO/T- 4842	4830
53	RDSO/T- 4843	4880
54	RDSO/T- 4844	4900
1E	RDSO/T- 5471	2550
2E	RDSO/T- 5472	2550
3E	RDSO/T- 5473	2550
4E	RDSO/T- 5474	2550

PARTS LIST (1 in 8.5 T/out)

Ref: Drg no. T-4865 latest alteration dated 21/07/2017

FOR 52 Kg			FOR 60 Kg (UIC)		
COMPONENT	PART No.	QUANTITY REQUIRED	COMPONENT	PART No.	QUANTITY REQUIRED
19113 mm LONG RAIL		1	19113 mm LONG RAIL		1
11855 mm LONG RAIL		1	11855 mm LONG RAIL		1
11813 mm LONG RAIL		1	11813 mm LONG RAIL		1
18966 mm LONG RAIL		1	18966 mm LONG RAIL		1
GROOVED RUBBER SOLE PLATES	RDSO/T- 8295	26	GROOVED RUBBER SOLE PLATES	RDSO/T- 8295	26
GROOVED RUBBER SOLE PLATES	RDSO/T- 8293	72	GROOVED RUBBER SOLE PLATES	RDSO/T- 8293	72
ELASTIC RAIL CLIPS	RDSO/T- 3701	196	ELASTIC RAIL CLIPS	RDSO/T- 3701	196
INSULATING LINERS	RDSO/T- 3707	98	INSULATING LINERS	RDSO/T- 3706	196
INSULATING LINERS	RDSO/T- 3708	98			
PLATE SCREWS	RDSO/T- 3912	30	PLATE SCREWS	RDSO/T- 3912	30
M.S. PLATES	RDSO/T- 3902	5	M.S. PLATES	RDSO/T- 3902	5
SINGLE COIL SPRING WASHERS	T 10773	30	SINGLE COIL SPRING WASHERS	T 10773	30

TABLE OF SLEEPERS AND THEIR FITTINGS

For 1 in 8.5 T/out CMS Xing (60 Kg) ***Ref: Drg no. T-4967 latest alteration dated 21/07/2017***

SLEEPER No.	DRAWING No.	GROOVED RUBBER SOLE PLATE												INSULATING LINER	ERC
		RDSO/T-6800/1	RDSO/T-6800	RDSO/T-6198	RDSO/T-6199	RDSO/T-6200	RDSO/T-6201	RDSO/T-6202	RDSO/T-6203	RDSO/T-6801	RDSO/T-6801/1	RDSO/T-8293	RDSO/T-8294	RDSO/T-3706	RDSO/T-3701
41	RDSO/T- 4831	1	--	--	--	--	--	--	--	--	--	--	2	7	7
42	RDSO/T- 4832	--	1	--	--	--	--	--	--	--	--	--	2	6	6
43	RDSO/T- 4833	--	--	1	--	--	--	--	--	--	--	--	2	6	6
44	RDSO/T- 4834	--	--	--	1	--	--	--	--	--	--	--	2	6	6
45	RDSO/T- 4835	--	--	--	--	1	--	--	--	--	--	--	2	6	6
46	RDSO/T- 4836	--	--	--	--	--	1	--	--	--	--	--	2	6	6
47	RDSO/T- 4837	--	--	--	--	--	--	1	--	--	--	--	2	6	6
48	RDSO/T- 4838	--	--	--	--	--	--	--	1	--	--	--	2	6	6
49	RDSO/T- 4839	--	--	--	--	--	--	--	--	1	--	2	--	6	6
50	RDSO/T- 4840	--	--	--	--	--	--	--	--	--	1	2	--	7	7
51	RDSO/T- 4841	--	--	--	--	--	--	--	--	--	--	4	--	8	8
52	RDSO/T- 4842	--	--	--	--	--	--	--	--	--	--	4	--	8	8
53	RDSO/T- 4843	--	--	--	--	--	--	--	--	--	--	4	--	8	8
54	RDSO/T- 4844	--	--	--	--	--	--	--	--	--	--	4	--	8	8

TABLE OF APPROACH SLEEPERS (for 1.8.5 T/out)

Ref: Drg no. T-4865 latest alteration dated 21/07/2017

SLEEPER No.	DRAWING No.	GRSP RDSO/T-8295	INSULATING LINERS FOR 52 Kg & 90 R		INSULATING LINERS FOR 60 Kg (UIC)	ERC RDSO/T-3701	ONE M.S. PLATE TO DRG. No.	PLATE SCREW RDSO/T- 3912
			RDSO/T-3707	RDSO/T-3708	RDSO/T-3706			
60 S	RDSO/T- 4786	2	2	2	4	4	RDSO/T- 3902	6
60-1AS	RDSO/T- 4787	2	2	2	4	4	RDSO/T- 3902	6
60-2AS	RDSO/T- 4788	2	2	2	4	4	RDSO/T- 3902	6
60-3A	RDSO/T- 4789	2	2	2	4	4	RDSO/T- 3902	6
60-4A	RDSO/T- 4790	2	2	2	4	4	RDSO/T- 3902	6

TABLE OF EXIT SLEEPERS

Ref: Drg no. T-4865 latest alteration dated 21/07/2017

(TWO SETS OF 4 SLEEPERS EACH AT THE EXIT OF THE TURNOUT)

SLEEPER No.	DRAWING No.	LENGTH	GRSP RDSO/T-8295	INSULATING LINERS FOR 52 Kg & 90 R		INSULATING LINERS FOR 60 Kg (UIC)	ERC RDSO/T-3701
				RDSO/T-3707	RDSO/T-3708	RDSO/T-3706	
1 E	RDSO/T- 5471	2550	2	2	2	4	4
2 E	RDSO/T- 5472	2550	2	2	2	4	4
3 E	RDSO/T- 5473	2550	2	2	2	4	4
4 E	RDSO/T- 5474	2550	2	2	2	4	4

TABLE OF SLEEPERS & THEIR FITTINGS (1 in 8.5 T/out)

Ref: Drg no. T-4866 latest alteration dated 21/07/2017

SLEEPER No.	SLEEPER TO DRG. No.	EXTENDED TIE PLATE FOR 52 Kg. RDSO/T- 5812 TO RDSO/T- 5812/2	2 Nos. GROOVED RUBBER SOLE PLATE TO DRG. No.	24 DIA. PLATE SCREW RDSO/T- 3912	INSULATING LINER RDSO/T-		ELASTIC RAIL CLIP RDSO/T- 3701	SLIDE CHAIR FOR 52 Kg RDSO/T- 5813	SINGLE COIL SPRING WASHER T 10773	**M.S. PLATE RDSO/T- 3901**
					3707	3708				
1 & 2	RDSO/T- 4791	------	RDSO/T- 8295	4	4	4	8	---	4	---
3	RDSO/T- 4793	ONE SET	RDSO/T- 3907 & RDSO/T- 4875	14	---	---	---	---	14	---
4	RDSO/T- 4794	------	------DO------	12	---	---	---	2	12	1
5	RDSO/T- 4795	------	RDSO/T- 4875	8	---	---	---	2	8	---
6	RDSO/T- 4796	------	------DO------	8	---	---	---	2	8	---
7	RDSO/T- 4797	------	------DO------	8	---	---	---	2	8	---
8	RDSO/T- 4798	------	------DO------	8	---	---	---	2	8	---
9	RDSO/T- 4799	------	------DO------	8	---	---	---	2	8	---
10	RDSO/T- 4800	------	------DO------	8	---	---	---	2	8	---
11	RDSO/T- 4801	------	------DO------	8	---	---	---	2	8	---
12	RDSO/T- 4802	------	------DO------	8	---	---	---	2	8	---
13	RDSO/T- 4803	------	------DO------	8	---	---	---	2	8	---

TABLE OF SLEEPERS & THEIR FITTINGS (1 in 8.5 T/out)

Ref: Drg no. T-4866 latest alteration dated 21/07/2017

SLEEPER No.	SLEEPER TO DRG. No.	2 Nos. GROOVED RUBBER SOLE PLATE TO DRG. No.	24 DIA. PLATE SCREW TO DRG. No. RDSO/T- 3912	SPL. FLAT BEARING PLATE TO DRG. No. 52 Kg/90R RIGHT/LEFT	GROOVED RUBBER SOLE PLATE RDSO/T- 4722	SINGLE COIL SPRING WASHER T10773	GROOVED RUBBER SOLE PLATE RDSO/T- 8293	ELASTIC RAIL CLIP RDSO/T- 3701	INSULATING LINER RDSO/T- 3702	INSULATING LINER RDSO/T- 3707	INSULATING LINER RDSO/T- 3708
14	RDSO/T- 4804	RDSO/T- 4876	8	RDSO/T- 4869 & RDSO/T- 4872	4	8	---	4	4	---	---
15	RDSO/T- 4805	RDSO/T- 4876	8	RDSO/T- 4870 & RDSO/T- 4873	4	8	---	4	4	---	---
16	RDSO/T- 4806	RDSO/T- 4876	8	RDSO/T- 4871 & RDSO/T- 4874	4	8	---	4	4	---	---
17	RDSO/T- 4807	-------	---	-------	---	---	4	6	---	3	3
18	RDSO/T- 4808	-------	---	-------	---	---	4	8	---	4	4
19	RDSO/T- 4809	-------	---	-------	---	---	4	8	---	4	4
20	RDSO/T- 4810	-------	---	-------	---	---	4	8	---	4	4
21	RDSO/T- 4811	-------	---	-------	---	---	4	8	---	4	4
22	RDSO/T- 4812	-------	---	-------	---	---	4	8	---	4	4

TABLE OF SLEEPERS AND THEIR FITTINGS

For 1 in 8.5 CMS Xing (52 Kg)

Ref: Drg no. T-4867 latest alteration dated 21/07/2017

SLEEPER No.	DRAWING No.	GROOVED RUBBER SOLE PLATE															ERC
		RDSO/T-8293	RDSO/T-8294	RDSO/T-6800/1	RDSO/T-6800	RDSO/T-6198	RDSO/T-6199	RDSO/T-6200	RDSO/T-6201	RDSO/T-6202	RDSO/T-6203	RDSO/T-6801	RDSO/T-6801/1	RDSO/T-3702	RDSO/T-3707	RDSO/T-3708	RDSO/T-3701
41	RDSO/T-4831	--	2	1	--	--	--	--	--	--	--	--	--	--	1	6	7
42	RDSO/T-4832	--	2	--	1	--	--	--	--	--	--	--	--	--	--	6	6
43	RDSO/T-4833	--	2	--	--	1	--	--	--	--	--	--	--	2	--	4	6
44	RDSO/T-4834	--	2	--	--	--	1	--	--	--	--	--	--	2	--	4	6
45	RDSO/T-4835	--	2	--	--	--	--	1	--	--	--	--	--	2	--	4	6
46	RDSO/T-4836	--	2	--	--	--	--	--	1	--	--	--	--	2	--	4	6
47	RDSO/T-4837	--	2	--	--	--	--	--	--	1	--	--	--	2	--	4	6
48	RDSO/T-4838	--	2	--	--	--	--	--	--	--	1	--	--	2	--	4	6
49	RDSO/T-4839	2	--	--	--	--	--	--	--	--	--	1	--	--	4	2	6
50	RDSO/T-4840	4	--	--	--	--	--	--	--	--	--	--	1	--	4	3	7
51	RDSO/T-4841	4	--	--	--	--	--	--	--	--	--	--	--	--	4	4	8
52	RDSO/T-4842	4	--	--	--	--	--	--	--	--	--	--	--	--	4	4	8
53	RDSO/T-4843	4	--	--	--	--	--	--	--	--	--	--	--	--	4	4	8
54	RDSO/T-4844	4	--	--	--	--	--	--	--	--	--	--	--	--	4	4	8

Ref: Drg no. T-4867 latest alteration dated 21/07/2017

PARTS LIST		
1 in 8.5 T/out FOR 52 Kg		
CMS CROSSING	RDSO/T- 4867/2	1
CHECK RAILS	RDSO/T- 4773	2
CHECK RAIL BLOCKS	RDSO/T- 4774	8
SINGLE COIL SPRING WASHERS	T 10773	20
INSULATING LINERS	RDSO/T- 3702	12
INSULATING LINERS	RDSO/T- 3707	25
INSULATING LINERS	RDSO/T- 3708	57
ELASTIC RAIL CLIPS	RDSO/T- 3701	95
PACKING PIECES	T 026 (M)	16
M.S. TAPERED WASHERS	RDSO/T- 5847	24
C.I. DISTANCE BLOCK	RDSO/T- 4894	1
C.I. DISTANCE BLOCK	RDSO/T- 4895	1
GROOVED RUBBER SOLE PLATES	RDSO/T- 8294	16
GROOVED RUBBER SOLE PLATES	RDSO/T- 8293	22
GROOVED RUBBER SOLE PLATE	RDSO/T- 6198	1
GROOVED RUBBER SOLE PLATE	RDSO/T- 6199	1
GROOVED RUBBER SOLE PLATE	RDSO/T- 6200	1
GROOVED RUBBER SOLE PLATE	RDSO/T- 6201	1
GROOVED RUBBER SOLE PLATE	RDSO/T- 6202	1
GROOVED RUBBER SOLE PLATE	RDSO/T- 6203	1
GROOVED RUBBER SOLE PLATE	RDSO/T- 6800	1
GROOVED RUBBER SOLE PLATE	RDSO/T- 6800/1	1
GROOVED RUBBER SOLE PLATE	RDSO/T- 6801	1
GROOVED RUBBER SOLE PLATE	RDSO/T- 6801/1	1
FISH PLATES (CROPPED, REFER NOTE No. 16)	RDSO/T- 5915	4
BOLTS 25X180	T 11513	8
BOLTS 25X310	T 11526	2
BOLTS 25X320	T 11527	2
BOLTS 25X340	T 11529	2
BOLTS 25X360	T 11531	2
BOLTS 25X380	T 11533	2
BOLTS 25X400	T 11535	2

PART LIST 1 in 8.5 T/out FOR 60 Kg

Ref: Drg no. T-4967 latest alteration dated 21/07/2017

PART	DESCRIPTION	No. OFF
T 11514	BOLTS 25X190	8
T 11525	BOLTS 25X300	1
T 11526	BOLTS 25X310	1
T 11527	BOLTS 25X320	1
T 11528	BOLTS 25X330	1
T 11529	BOLTS 25X340	1
T 11530	BOLTS 25X350	1
T 11531	BOLTS 25X360	1
T 11532	BOLTS 25X370	1
T 11533	BOLTS 25X380	1
T 11534	BOLTS 25X390	1
T 11535	BOLTS 25X400	1
T 11536	BOLTS 25X410	1
RDSO/T- 5916	FISH PLATES (CROPPED, REF: NOTE No. 14)	4
RDSO/T- 6800	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 6800/1	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 6801	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 6801/1	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 6203	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 6202	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 6201	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 6200	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 6199	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 6198	GROOVED RUBBER SOLE PLATES	1
RDSO/T- 8293	GROOVED RUBBER SOLE PLATES	20
RDSO/T- 8294	GROOVED RUBBER SOLE PLATES	16
RDSO/T- 4988	C.I. DISTANCE BLOCK	1
RDSO/T- 4987	C.I. DISTANCE BLOCK	1
RDSO/T- 5847	M.S. TAPERED WASHERS	24
T 10773	SINGLE COIL SPRING WASHERS	20
RDSO/T- 3701	ELASTIC RAIL CLIPS	94
RDSO/T- 3706	INSULATING LINERS	94
T 026(M)	PACKING PIECES	16
RDSO/T- 2592	CHECK RAIL BLOCKS	8
RDSO/T- 4018	CHECK RAILS	2
RDSO/T- 4967/1	C.M.S. CROSSING	1

Ref: Drg no. T-4866 latest alteration dated 21/07/2017

PARTS LIST (1 in 8.5 T/out)		
FOR 52 Kg.		
COMPONENT	PART NUMBER	QUANTITY REQUIRED
STOCK RAIL RIGHT	RDSO/T- 4866/2	1
STOCK RAIL LEFT	RDSO/T- 4866/2	1
TONGUE RAIL RIGHT	RDSO/T- 4866/2	1
TONGUE RAIL LEFT	RDSO/T- 4866/2	1
BEARING PLATE	RDSO/T- 4869 TO RDSO/T- 4874	ONE EACH
HEEL BLOCKS	T 15561	2
DISTANCE BLOCKS	T 15562	2
DISTANCE BLOCKS	RDSO/T- 4878	2
STOP BOLTS 18X65	T 11627	8
STOPS	T 10456	2
STOPS	T 10457	2
SPHERICAL WASHERS	T 023 (M)	8
BOLTS FOR M.S.S.C. COMP. 25X80	T 11623	20
BOLTS FOR M.S.S.C. COMP. 25X80 HALF HEAD (11 mm TH. BOLT-HEAD)	T 11624	4+4*=8
PLATE SCREWS	RDSO/T- 3912	126
FISH PLATES	RDSO/T- 5915	4
FISH BOLTS	T 11509	12
SINGLE COIL SPRING WASHERS	T 10773	186
LEADING STR. BAR INSULATED	RDSO/T- 4885 & RDSO/T- 4886	ONE SET
1st FOLLOWING STR. BAR INSULATED	RDSO/T- 4887 & RDSO/T- 4888	ONE SET
2nd FOLLOWING STR. BAR NSULATED	RDSO/T- 4889 & RDSO/T- 4890	ONE SET
LUG	T 083 (M)	1
INSULATING LINERS	RDSO/T- 3707	27
INSULATING LINERS	RDSO/T- 3708	27
INSULATING LINERS	RDSO/T- 3702	12
ELASTIC RAIL CLIPS	RDSO/T- 3701	66
GROOVED RUBBER SOLE PLATES	RDSO/T- 8293	24
GROOVED RUBBER SOLE PLATES	RDSO/T- 8295	4
GROOVED RUBBER SOLE PLATES	RDSO/T- 4722	12
GROOVED RUBBER SOLE PLATES	RDSO/T- 4875	22
GROOVED RUBBER SOLE PLATES	RDSO/T- 4876	6
BOLTS 25X270	T 11522	2
BOLTS 25X280	T 11523	2
BOLTS 25X300	T 11525	2
BOLTS 25X360	T 11531	2
TURNED BOLTS 18X75	T 11634	2
TURNED BOLTS 18X80	T 11635	12
BOLTS CUT HEAD 18X85	T 11636	12
GROOVED RUBBER SOLE PLATES	RDSO/T- 3907	4
M.S. PLATE	RDSO/T- 3901	1
M.S. FLAT TIE BAR	RDSO/T- 4711	2
CHECK RAILS	RDSO/T- 4773	2
INSULATED TIE PLATE (EXTENDED)	RDSO/T- 5812 TO RDSO/T- 5812/2	ONE SET
SLIDE CHAIRS	RDSO/T- 5813	20

OTHER SPECIAL & MISC. ITEMS FOR FAN SHAPED TURNOUT : (1 IN 8.5, 60 KG)

1	Over riding switch L&R complete sets RT-4966 details: Switch length = 6400mm, length of Tongue rail = 11900 mm, stock rail length = 12800mm switch angle 0'46'59" Hd. = 182.5mm, radius R=232260mm, G=1673mm, Throw of switch=115mm.
2	CMS crossing 1 in 8.5, 60 kg. drg. No. RT-4967/1, length=3330mm, angle 6^0 42'35".
3	Check rails 60 kg., drg. No. RT-4773=2 nos. length = 4330 mm, check blocks RT-4774 = 8 nos. with Bolts and nuts T-11513 (25x180) & packing pieces T-026 (M).
4	Total No. of Fish plate required T-090(M) = 20 nos. Fish Bolts T-11501 = 32 nos.
5	Overall length of turnout = 28247mm, rails required (1) 18966mm (2) 11813mm (3) 11815mm, (4) 19113mm as lead rails.

NOTES

1	Same set of sleepers from 1 to 54 and approach sleepers can be used in RH and LH turnouts by mutual interchanging of sleeper spacing on outer and inner rails.
2	Sleeper No. 1 to 13 are perpendicular to main line, 14 to 41 are laid Fan Shaped i.e. their spacing are different at RH & LH gauge faces of straight track, sleeper no.42 to 54 are laid perpendicular to center line of crossing, spacing are measured at gauge faces of L&R rail of main line track.
3	Single coil spring washer T-10773 shall be used with all 25mm dia bolts and all plate screws T-3912.
4	Three bolts are provided at either end of fish plated joint of CMS crossings.
5	Metal liner RT-3740 will be used in place of GFN liner RT-3706 respectively in non-track circuited areas.
6.	Every PSC sleeper has got RE engraved at right end and should be laid irrespective of LH/RH Turnout.

OTHER SPECIAL & MISC. ITEMS FOR FAN SHAPED TURNOUT : (1 IN 8.5, 52 KG)

1	Over riding switch L&R complete sets RDSO T-4866 Details: Switch length = 6400mm, length of Tongue rail = 11900 mm, stock rail length = 12800mm, switch angle 0^{0}46'59" Hd = 182.5mm, radius R=232260mm, G=1673mm, Throw of switch=115mm.
2	CMS crossing 1 in 8.5, 52 kg drg. No. RT-4734/1, length=3330mm, angle 6^{0} 42' 35".
3	Check rails 52 kg, drg. No.RT-4773=2 nos, length = 4330 mm, check bolts RT-4774 = 8 nos. with Bolts and nuts T-11513 (25x180) & packing pieces T-026 (M).
4	Total No. of Fish plate required T-090(M)= 20 nos. Fish Bolts T-11501 = 32 nos.
5	Overall length of turnout = 28247 (Approx.) mm, rails required (1) 18966mm (2) 11813mm (3) 11855mm, (4) 19113mm as lead rails.

Notes

1	Same set of sleepers from 1 to 54 and approach sleepers can be used in RH and LH turnouts by mutual interchanging of sleeper spacing on outer and inner rails.
2	Sleeper No. 1 to 13 are perpendicular to main line, 14 to 41 are laid Fan Shaped i.e. their spacing are different at RH & LH gauge faces of straight track, sleeper no. 42 to 54 are laid perpendicular to center line of crossing.
3	Single coil spring washer T-10773 shall be used with all 25mm dia bolts and all plate screws T-3912.
4	Three bolts are provided at either end of fish plated joint of CMS crossings.
5	Metal liner RT-3738, RT-3741 and RT-3742 will be used in place of GFN liner RT-3702, RT-3707 and RT-3708, respectively in non-track circuited areas.
6.	Every PSC sleeper has got RE engraved at right end and should be laid irrespective of LH/RH Turnout.

Annexure - 4

Sleeper spacing for 1 in 12 over riding switch for different curvature for Similar Flexure layout: 'A' side is one where crossing lies

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing on (B side)	Cumulative B Side distance from SRJ	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ on (B side)	Sleeper spacing inner-most side on turnout side
					For 1 degree curve			For 2 degree curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	150	150	150	150	150.0	150.0		150.0	150.0	
2	457	607	457	607	457.0	607.0		457.0	607.0	
3	505	1112	505	1112	505.0	1112.0		505.0	1112.0	
4	745	1857	745	1857	745.0	1857.0		745.0	1857.0	
5	492	2349	492	2349	492.0	2349.0		492.0	2349.0	
6	550	2899	550	2899	550.0	2899.0		550.0	2899.0	
7	550	3449	550	3449	550.0	3449.0		550.0	3449.0	
8	550	3999	550	3999	550.0	3999.0		550.0	3999.0	
9	550	4549	550	4549	550.0	4549.0		550.0	4549.0	
10	550	5099	550	5099	550.0	5099.0		550.0	5099.0	
11	550	5649	550	5649	550.0	5649.0		550.0	5649.0	
12	550	6199	550	6199	550.0	6199.0		550.0	6199.0	
13	550	6749	550	6749	550.0	6749.0		550.0	6749.0	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing on (B side)	Cumulative B Side distance from SRJ	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ on (B side)	Sleeper spacing inner-most side on turnout side
					For 1 degree curve			For 2 degree curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
14	550	7299	550	7299	550.0	7299.0		550.0	7299.0	
15	550	7849	550	7849	550.0	7849.0		550.0	7849.0	
16	550	8399	550	8399	550.0	8399.0		550.0	8399.0	
17	550	8949	550	8949	550.0	8949.0		550.0	8949.0	
18	550	9499	550	9499	550.0	9499.0		550.0	9499.0	
19	550	10049	550	10049	550.0	10049.0		550.0	10049.0	
20	550	10599	550	10599	550.0	10599.0		550.0	10599.0	
21	526	11125	550	11149	560.4	11159.4		571.1	11170.1	
22	549	11674	550	11699	550.6	11710.0		551.1	11721.2	
23	549	12223	550	12249	550.6	12260.6		551.1	12272.3	
24	549	12772	550	12799	550.6	12811.1		551.1	12823.4	
25	549	13321	550	13349	550.6	13361.7		551.1	13374.4	
26	549	13870	550	13899	550.6	13912.3		551.1	13925.5	
27	549	14419	550	14449	550.6	14462.8		551.1	14476.6	
28	549	14968	550	14999	550.6	15013.4		551.1	15027.7	

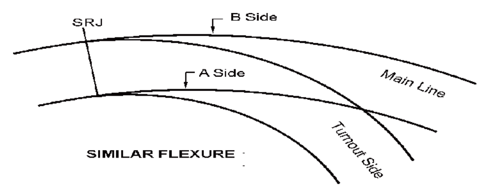
Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing on (B side)	Cumulative B Side distance from SRJ	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ on (B side)	Sleeper spacing inner-most side on turnout side
					For 1 degree curve			For 2 degree curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
29	549	15517	550	15549	550.6	15564.0		551.1	15578.8	
30	549	16066	550	16099	550.6	16114.5		551.1	16129.9	
31	549	16615	550	16649	550.6	16665.1		551.1	16681.0	
32	549	17164	550	17199	550.6	17215.7		551.1	17232.1	
33	549	17713	550	17749	550.6	17766.2		551.1	17783.2	
34	549	18262	550	18299	550.6	18316.8		551.1	18334.3	
35	549	18811	550	18849	550.6	18867.4		551.1	18885.4	
36	549	19360	550	19399	550.6	19417.9		551.1	19436.5	
37	548	19908	550	19949	549.6	19967.5		550.1	19986.5	
38	549	20457	550	20499	550.6	20518.0		551.1	20537.6	
39	549	21006	550	21049	550.6	21068.6		551.1	21088.7	
40	549	21555	550	21599	550.6	21619.2		551.1	21639.8	
41	549	22104	550	22149	550.6	22169.7		551.1	22190.9	
42	549	22653	550	22699	550.6	22720.3		551.1	22742.0	
43	549	23202	550	23249	550.6	23270.9		551.1	23293.1	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing on (B side)	Cumulative B Side distance from SRJ	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ on (B side)	Sleeper spacing inner-most side on turnout side
					For 1 degree curve			For 2 degree curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
44	549	23751	550	23799	550.6	23821.4		551.1	23844.2	
45	549	24300	550	24349	550.6	24372.0		551.1	24395.3	
46	549	24849	550	24899	550.6	24922.6		551.1	24946.4	
47	549	25398	550	25449	550.6	25473.1		551.1	25497.5	
48	549	25947	550	25999	550.6	26023.7		551.1	26048.5	
49	549	26496	550	26549	550.6	26574.3		551.1	26599.6	
50	549	27045	550	27099	550.6	27124.8		551.1	27150.7	
51	549	27594	550	27649	550.6	27675.4		551.1	27701.8	
52	549	28143	550	28199	550.6	28226.0		551.1	28252.9	
53	549	28692	550	28749	550.6	28776.5		551.1	28804.0	
54	549	29241	550	29299	550.6	29327.1		551.1	29355.1	
55	549	29790	550	29849	550.6	29877.7		551.1	29906.2	
56	549	30339	550	30399	550.6	30428.2		551.1	30457.3	
57	549	30888	550	30949	550.6	30978.8		551.1	31008.4	
58	549	31437	550	31499	550.6	31529.4		551.1	31559.5	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing on (B side)	Cumulative B Side distance from SRJ	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ on (B side)	Sleeper spacing inner-most side on turnout side
					For 1 degree curve			For 2 degree curve		
1	2	3	4	5	6	7	8	9	10	11
59	549	31986	550	32049	550.6	32079.9		551.1	32110.5	
60	549	32535	550	32599	550.6	32630.5		551.1	32661.6	
61	548	33083	550	33149	549.6	33180.1		550.1	33211.7	
62	549	33632	550	33699	550.6	33730.6		551.1	33762.8	
63	549	34181	550	34249	550.6	34281.2		551.1	34313.9	
64	549	34730	550	34799	550.6	34831.7		551.1	34865.0	
65	549	35279	550	35349	550.6	35382.3		551.1	35416.1	
66	550	35829	550	35899	550	35932.3		550.0	35966.1	
67	550	36379	550	36449	550	36482.3		550.0	36516.1	
68	550	36929	550	36999	550	37032.3		550.0	37066.1	
69	550	37479	550	37549	550	37582.3		550.0	37616.1	
70	550	38029	550	38099	550	38132.3		550.0	38166.1	
71	550	38579	550	38649	550	38682.3		550.0	38716.1	
72	550	39129	550	39199	550	39232.3	550	550.0	39266.1	550
73	550	39679	550	39749	550	39782.3	550	550.0	39816.1	550

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing on (B side)	Cumulative B Side distance from SRJ	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ on (B side)	Sleeper spacing inner-most side on turnout side
					For 1 degree curve			For 2 degree curve		
1	2	3	4	5	6	7	8	9	10	11
74	550	40229	550	40299	550.5	40332.8	549.5	551.1	40367.2	548.9
75	550	40779	550	40849	550.5	40883.4	549.5	551.1	40918.2	548.9
76	550	41329	550	41399	550.5	41433.9	549.5	551.1	41469.3	548.9
77	550	41879	550	41949	550.6	41984.5	549.4	551.1	42020.4	548.9
78	550	42429	550	42499	550.6	42535.1	549.4	551.1	42571.6	548.9
79	550	42979	550	43049	550.6	43085.6	549.4	551.1	43122.7	548.9
80	550	43529	550	43599	550.6	43636.2	549.4	551.2	43673.9	548.8
81	550	44079	550	44149	550.6	44186.8	549.4	551.2	44225.0	548.8
82	550	44629	550	44699	550.6	44737.4	549.4	551.2	44776.2	548.8
83	550	45179	550	45249	550.6	45288.0	549.4	551.2	45327.4	548.8

Note :- Sleeper spacing in crossing zone after sleeper no-73, B side is outer rail of main line (col.6 & 9) and innermost sleeper spacing as given in col. 8 &11 is to be seen inside rail of turnout side



SIMILAR FLEXURE

Annexure - 5

Sleeper spacing for 1 in 12 Over Riding Switch for different curvature for Contrary Flexure layout: 'A' side is one where crossing lies

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ (A side)	Sleeper spacing on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles B side	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	150	150	150	150	150.0	150.0		150.0	150.0		150.0	150.0		150.0	150.0		150.0	150.0	
2	457	607	457	607	457.0	607.0		457.0	607.0		457.0	607.0		457.0	607.0		457.0	607.0	
3	505	1112	505	1112	505.0	1112.0		505.0	1112.0		505.0	1112.0		505.0	1112.0		505.0	1112.0	
4	745	1857	745	1857	745.0	1857.0		745.0	1857.0		745.0	1857.0		745.0	1857.0		745.0	1857.0	
5	492	2349	492	2349	492.0	2349.0		492.0	2349.0		492.0	2349.0		492.0	2349.0		492.0	2349.0	
6	550	2899	550	2899	550.0	2899.0		550.0	2899.0		550.0	2899.0		550.0	2899.0		550.0	2899.0	
7	550	3449	550	3449	550.0	3449.0		550.0	3449.0		550.0	3449.0		550.0	3449.0		550.0	3449.0	
8	550	3999	550	3999	550.0	3999.0		550.0	3999.0		550.0	3999.0		550.0	3999.0		550.0	3999.0	
9	550	4549	550	4549	550.0	4549.0		550.0	4549.0		550.0	4549.0		550.0	4549.0		550.0	4549.0	
10	550	5099	550	5099	550.0	5099.0		550.0	5099.0		550.0	5099.0		550.0	5099.0		550.0	5099.0	
11	550	5649	550	5649	550.0	5649.0		550.0	5649.0		550.0	5649.0		550.0	5649.0		550.0	5649.0	
12	550	6199	550	6199	550.0	6199.0		550.0	6199.0		550.0	6199.0		550.0	6199.0		550.0	6199.0	
13	550	6749	550	6749	550.0	6749.0		550.0	6749.0		550.0	6749.0		550.0	6749.0		550.0	6749.0	
14	550	7299	550	7299	550.0	7299.0		550.0	7299.0		550.0	7299.0		550.0	7299.0		550.0	7299.0	
15	550	7849	550	7849	550.0	7849.0		550.0	7849.0		550.0	7849.0		550.0	7849.0		550.0	7849.0	

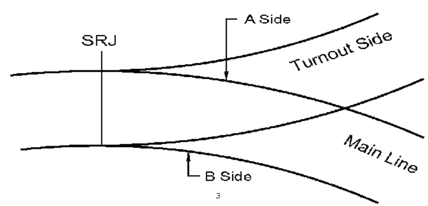
Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ (A side)	Sleeper spacing on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles B side	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			**For 2 Degree Curve**			**For 3 Degree Curve**			**For 4 Degree Curve**			**For 5 Degree Curve**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
16	550	8399	550	8399	550.0	8399.0		550.0	8399.0		550.0	8399.0		550.0	8399.0		550.0	8399.0	
17	550	8949	550	8949	550.0	8949.0		550.0	8949.0		550.0	8949.0		550.0	8949.0		550.0	8949.0	
18	550	9499	550	9499	550.0	9499.0		550.0	9499.0		550.0	9499.0		550.0	9499.0		550.0	9499.0	
19	550	10049	550	10049	550.0	10049.0		550.0	10049.0		550.0	10049.0		550.0	10049.0		550.0	10049.0	
20	550	10599	550	10599	550.0	10599.0		550.0	10599.0		550.0	10599.0		550.0	10599.0		550.0	10599.0	
21	526	11125	549.79	11148.79	539.2	11138.2		528.5	11127.5		517.9	11116.9		507.7	11106.7		496.7	11095.7	
22	549	11674	550.04	11698.83	549.5	11687.7		549.0	11676.5		548.5	11665.4		548.0	11654.6		547.4	11643.2	
23	549	12223	550.04	12248.87	549.5	12237.2		549.0	12225.5		548.5	12213.9		548.0	12202.6		547.4	12190.6	
24	549	12772	550.04	12798.91	549.5	12786.7		549.0	12774.5		548.5	12762.3		548.0	12750.6		547.4	12738.0	
25	549	13321	550.04	13348.95	549.5	13336.3		549.0	13323.5		548.5	13310.8		548.0	13298.5		547.4	13285.4	
26	549	13870	550.04	13898.99	549.5	13885.8		549.0	13872.5		548.5	13859.3		548.0	13846.5		547.4	13832.9	
27	549	14419	550.04	14449.03	549.5	14435.3		549.0	14421.5		548.5	14407.7		548.0	14394.4		547.4	14380.3	
28	549	14968	550.04	14999.07	549.5	14984.8		549.0	14970.5		548.5	14956.2		548.0	14942.4		547.4	14927.7	
29	549	15517	550.04	15549.11	549.5	15534.3		549.0	15519.5		548.5	15504.7		548.0	15490.4		547.4	15475.1	
30	549	16066	550.04	16099.15	549.5	16083.8		549.0	16068.5		548.5	16053.1		548.0	16038.3		547.4	16022.5	
31	549	16615	550.04	16649.20	549.5	16633.4		549.0	16617.5		548.5	16601.6		548.0	16586.3		547.4	16570.0	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ (A side)	Sleeper spacing on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles B side	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			**For 2 Degree Curve**			**For 3 Degree Curve**			**For 4 Degree Curve**			**For 5 Degree Curve**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
32	549	17164	550.04	17199.24	549.5	17182.9		549.0	17166.5		548.5	17150.1		548.0	17134.3		547.4	17117.4	
33	549	17713	550.04	17749.28	549.5	17732.4		549.0	17715.4		548.5	17698.6		548.0	17682.2		547.4	17664.8	
34	549	18262	550.04	18299.32	549.5	18281.9		549.0	18264.4		548.5	18247.0		548.0	18230.2		547.4	18212.2	
35	549	18811	550.04	18849.36	549.5	18831.4		549.0	18813.4		548.5	18795.5		548.0	18778.2		547.4	18759.7	
36	549	19360	550.04	19399.40	549.5	19380.9		549.0	19362.4		548.5	19344.0		548.0	19326.1		547.4	19307.1	
37	548	19908	549.04	19948.44	548.5	19929.4		548.0	19910.4		547.5	19891.4		547.0	19873.1		546.4	19853.5	
38	549	20457	550.04	20498.48	549.5	20478.9		549.0	20459.4		548.5	20439.9		548.0	20421.0		547.4	20400.9	
39	549	21006	550.04	21048.52	549.5	21028.4		549.0	21008.4		548.5	20988.4		548.0	20969.0		547.4	20948.4	
40	549	21555	550.04	21598.56	549.5	21578.0		549.0	21557.4		548.5	21536.8		548.0	21517.0		547.4	21495.8	
41	549	22104	550.04	22148.60	549.5	22127.5		549.0	22106.4		548.5	22085.3		548.0	22064.9		547.4	22043.2	
42	549	22653	550.04	22698.65	549.5	22677.0		549.0	22655.4		548.5	22633.8		548.0	22612.9		547.4	22590.6	
43	549	23202	550.04	23248.69	549.5	23226.5		549.0	23204.4		548.5	23182.2		548.0	23160.9		547.4	23138.0	
44	549	23751	550.04	23798.73	549.5	23776.0		549.0	23753.4		548.5	23730.7		548.0	23708.8		547.4	23685.5	
45	549	24300	550.04	24348.77	549.5	24325.5		549.0	24302.3		548.5	24279.2		548.0	24256.8		547.4	24232.9	
46	549	24849	550.04	24898.81	549.5	24875.1		549.0	24851.3		548.5	24827.6		548.0	24804.8		547.4	24780.3	
47	549	25398	550.04	25448.85	549.5	25424.6		549.0	25400.3		548.5	25376.1		548.0	25352.7		547.4	25327.7	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ (A side)	Sleeper spacing on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles B side	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
48	549	25947	550.04	25998.89	549.5	25974.1		549.0	25949.3		548.5	25924.6		548.0	25900.7		547.4	25875.2	
49	549	26496	550.04	26548.94	549.5	26523.6		549.0	26498.3		548.5	26473.0		548.0	26448.6		547.4	26422.6	
50	549	27045	550.04	27098.98	549.5	27073.1		549.0	27047.3		548.5	27021.5		548.0	26996.6		547.4	26970.0	
51	549	27594	550.04	27649.02	549.5	27622.6		549.0	27596.3		548.5	27570.0		548.0	27544.6		547.4	27517.4	
52	549	28143	550.04	28199.06	549.5	28172.2		549.0	28145.3		548.5	28118.4		548.0	28092.5		547.4	28064.8	
53	549	28692	550.04	28749.10	549.5	28721.7		549.0	28694.3		548.5	28666.9		548.0	28640.5		547.4	28612.3	
54	549	29241	550.04	29299.14	549.5	29271.2		549.0	29243.3		548.5	29215.4		548.0	29188.5		547.4	29159.7	
55	549	29790	550.04	29849.18	549.5	29820.7		549.0	29792.3		548.5	29763.9		548.0	29736.4		547.4	29707.1	
56	549	30339	550.04	30399.22	549.5	30370.2		549.0	30341.3		548.5	30312.3		548.0	30284.4		547.4	30254.5	
57	549	30888	550.04	30949.26	549.5	30919.7		549.0	30890.2		548.5	30860.8		548.0	30832.4		547.4	30802.0	
58	549	31437	550.04	31499.30	549.5	31469.3		549.0	31439.2		548.5	31409.3		548.0	31380.3		547.4	31349.4	
59	549	31986	550.04	32049.34	549.5	32018.8		549.0	31988.2		548.5	31957.7		548.0	31928.3		547.4	31896.8	
60	549	32535	550.04	32599.39	549.5	32568.3		549.0	32537.2		548.5	32506.2		548.0	32476.2		547.4	32444.2	
61	548	33083	549.04	33148.42	548.5	33116.8		548.0	33085.2		547.5	33053.7		547.0	33023.2		546.4	32990.6	
62	549	33632	550.04	33698.47	549.5	33666.3		549.0	33634.2		548.5	33602.1		548.0	33571.2		547.4	33538.1	
63	549	34181	550.04	34248.51	549.5	34215.8		549.0	34183.2		548.5	34150.6		548.0	34119.1		547.4	34085.5	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ (A side)	Sleeper spacing on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles B side	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
64	549	34730	550.04	34798.55	549.5	34765.3		549.0	34732.2		548.5	34699.1		548.0	34667.1		547.4	34632.9	
65	549	35279	550.04	35348.59	549.5	35314.9		549.0	35281.2		548.5	35247.5		548.0	35215.1		547.4	35180.3	
66	550	35829	550.00	35898.59	550	35864.9		550.0	35831.2		550.0	35797.5		550.0	35765.1		550.0	35730.3	
67	550	36379	550.00	36448.59	550	36414.9		550.0	36381.2		550.0	36347.5		550.0	36315.1		550.0	36280.3	
68	550	36929	550.00	36998.59	550	36964.9		550.0	36931.2		550.0	36897.5		550.0	36865.1		550.0	36830.3	
69	550	37479	550.00	37548.58	550	37514.9		550.0	37481.2		550.0	37447.5		550.0	37415.1		550.0	37380.3	
70	550	38029	550.00	38098.58	550	38064.9		550.0	38031.2		550.0	37997.5		550.0	37965.1		550.0	37930.3	
71	550	38579	550.00	38648.58	550	38614.9		550.0	38581.2		550.0	38547.5		550.0	38515.1		550.0	38480.3	
72	550	39129	550.00	39198.58	550	39164.9		550.0	39131.2		550.0	39097.5		550.0	39065.1		550.0	39030.3	
73	550	39679	550.00	39748.58	550	39714.9		550.0	39681.2		550.0	39647.5		550.0	39615.1		550.0	39580.3	
74	550	40229	550.00	40298.58	549.5	40264.3	550.5	548.9	40230.1	551.1	548.4	40195.9	551.6	547.9	40162.9	552.1	547.3	40127.7	552.7
75	550	40779	550.00	40848.58	549.5	40813.8	550.5	548.9	40779.0	551.1	548.4	40744.3	551.6	547.8	40710.8	552.2	547.3	40675.0	552.7
76	550	41329	550.00	41398.58	549.5	41363.2	550.5	548.9	41327.9	551.1	548.4	41292.7	551.6	547.8	41258.6	552.2	547.3	41222.3	552.7
77	550	41879	550.00	41948.58	549.4	41912.7	550.6	548.9	41876.8	551.1	548.3	41841.0	551.7	547.8	41806.4	552.2	547.2	41769.5	552.8
78	550	42429	550.00	42498.58	549.4	42462.1	550.6	548.9	42425.7	551.1	548.3	42389.3	551.7	547.8	42354.1	552.2	547.2	42316.7	552.8
79	550	42979	550.00	43048.58	549.4	43011.6	550.6	548.9	42974.6	551.1	548.3	42937.6	551.7	547.7	42901.9	552.3	547.2	42863.9	552.8

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ (A side)	Sleeper spacing on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles B side	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC	Sleeper spacing on B side	Cumulative distance from SRJ (B Side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			**For 2 Degree Curve**			**For 3 Degree Curve**			**For 4 Degree Curve**			**For 5 Degree Curve**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
80	550	43529	550.00	43598.58	549.4	43561.0	550.6	548.8	43523.4	551.2	548.3	43485.9	551.7	547.7	43449.6	552.3	547.1	43411.0	552.9
81	550	44079	550.00	44148.58	549.4	44110.4	550.6	548.8	44072.3	551.2	548.3	44034.2	551.7	547.7	43997.2	552.3	547.1	43958.1	552.9
82	550	44629	550.00	44698.58	549.4	44659.8	550.6	548.8	44621.1	551.2	548.2	44582.4	551.8	547.6	44544.9	552.4	547.1	44505.1	552.9
83	550	45179	550.00	45248.58	549.4	45209.2	550.6	548.8	45169.9	551.2	548.2	45130.6	551.8	547.6	45092.5	552.4	547.0	45052.2	553.0



CONTRARY FLEXURE

Annexure - 6

Sleeper spacing for 1 in 12 Thick Web Switch for different curvature for Similar Flexure layout: 'A' side is one where crossing lies

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Sleeper spacing inner-most side on turnout side after HOC
					For 1 Degree Curve			For 2 Degree Curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	150	150	150	150	150.1	150.1		150.3	150.3	
2	457	607	457	607	457.4	607.6		457.9	608.2	
3	505	1112	505	1112	505.5	1113.1		506.0	1114.1	
4	745	1857	745	1857	745.7	1858.8		746.4	1860.6	
5	492	2349	492	2349	492.5	2351.2		492.9	2353.5	
6	550	2899	550	2899	550.5	2901.8		551.1	2904.5	
7	550	3449	550	3449	550.5	3452.3		551.1	3455.6	
8	550	3999	550	3999	550.5	4002.8		551.1	4006.7	
9	550	4549	550	4549	550.5	4553.4		551.1	4557.7	
10	550	5099	550	5099	550.5	5103.9		551.1	5108.8	
11	550	5649	550	5649	550.5	5654.4		551.1	5659.8	
12	550	6199	550	6199	550.5	6204.9		551.1	6210.9	
13	550	6749	550	6749	550.5	6755.5		551.1	6761.9	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Sleeper spacing inner-most side on turnout side after HOC
					For 1 Degree Curve			**For 2 Degree Curve**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
14	550	7299	550	7299	550.5	7306.0		551.1	7313.0	
15	550	7849	550	7849	550.5	7856.5		551.1	7864.0	
16	550	8399	550	8399	550.5	8407.0		551.1	8415.1	
17	550	8949	550	8949	550.5	8957.6		551.1	8966.1	
18	550	9499	550	9499	550.5	9508.1		551.1	9517.2	
19	550	10049	550	10049	550.5	10058.6		551.1	10068.2	
20	550	10599	550	10599	550.5	10609.1		551.1	10619.3	
21	526	11125	550	11149	550.3	11159.4		550.8	11170.1	
22	549	11674	550	11699	550.6	11710.0		551.1	11721.2	
23	549	12223	550	12249	550.6	12260.6		551.1	12272.3	
24	549	12772	550	12799	550.6	12811.1		551.1	12823.4	
25	549	13321	550	13349	550.6	13361.7		551.1	13374.4	
26	549	13870	550	13899	550.6	13912.3		551.1	13925.5	
27	549	14419	550	14449	550.6	14462.8		551.1	14476.6	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Sleeper spacing inner-most side on turnout side after HOC
					For 1 Degree Curve			For 2 Degree Curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
28	549	14968	550	14999	550.6	15013.4		551.1	15027.7	
29	549	15517	550	15549	550.6	15564.0		551.1	15578.8	
30	549	16066	550	16099	550.6	16114.5		551.1	16129.9	
31	549	16615	550	16649	550.6	16665.1		551.1	16681.0	
32	549	17164	550	17199	550.6	17215.7		551.1	17232.1	
33	549	17713	550	17749	550.6	17766.2		551.1	17783.2	
34	549	18262	550	18299	550.6	18316.8		551.1	18334.3	
35	549	18811	550	18849	550.6	18867.4		551.1	18885.4	
36	549	19360	550	19399	550.6	19417.9		551.1	19436.5	
37	548	19908	550	19949	549.6	19967.5		550.1	19986.5	
38	549	20457	550	20499	550.6	20518.0		551.1	20537.6	
39	549	21006	550	21049	550.6	21068.6		551.1	21088.7	
40	549	21555	550	21599	550.6	21619.2		551.1	21639.8	
41	549	22104	550	22149	550.6	22169.7		551.1	22190.9	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Sleeper spacing inner-most side on turnout side after HOC
					For 1 Degree Curve			For 2 Degree Curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
42	549	22653	550	22699	550.6	22720.3		551.1	22742.0	
43	549	23202	550	23249	550.6	23270.9		551.1	23293.1	
44	549	23751	550	23799	550.6	23821.4		551.1	23844.2	
45	549	24300	550	24349	550.6	24372.0		551.1	24395.3	
46	549	24849	550	24899	550.6	24922.6		551.1	24946.4	
47	549	25398	550	25449	550.6	25473.1		551.1	25497.5	
48	549	25947	550	25999	550.6	26023.7		551.1	26048.5	
49	549	26496	550	26549	550.6	26574.3		551.1	26599.6	
50	549	27045	550	27099	550.6	27124.8		551.1	27150.7	
51	549	27594	550	27649	550.6	27675.4		551.1	27701.8	
52	549	28143	550	28199	550.6	28226.0		551.1	28252.9	
53	549	28692	550	28749	550.6	28776.5		551.1	28804.0	
54	549	29241	550	29299	550.6	29327.1		551.1	29355.1	
55	549	29790	550	29849	550.6	29877.7		551.1	29906.2	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Sleeper spacing inner-most side on turnout side after HOC
					For 1 Degree Curve			For 2 Degree Curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
56	549	30339	550	30399	550.6	30428.2		551.1	30457.3	
57	549	30888	550	30949	550.6	30978.8		551.1	31008.4	
58	549	31437	550	31499	550.6	31529.4		551.1	31559.5	
59	549	31986	550	32049	550.6	32079.9		551.1	32110.5	
60	549	32535	550	32599	550.6	32630.5		551.1	32661.6	
61	548	33083	550	33149	549.6	33180.1		550.1	33211.7	
62	549	33632	550	33699	550.6	33730.6		551.1	33762.8	
63	549	34181	550	34249	550.6	34281.2		551.1	34313.9	
64	549	34730	550	34799	550.6	34831.7		551.1	34865.0	
65	549	35279	550	35349	550.6	35382.3		551.1	35416.1	
66	550	35829	550	35899	550.0	35932.3		550.0	35966.1	
67	550	36379	550	36449	550.0	36482.3		550.0	36516.1	
68	550	36929	550	36999	550.0	37032.3		550.0	37066.1	
69	550	37479	550	37549	550.0	37582.3		550.0	37616.1	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ for turnout taking off from straight (A side)	Spacing as per RDSO drg for turnout taking off from straight (B side)	Cumulative spacing as per RDSO Drg for turnout taking off from straight (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Sleeper spacing of inner-most side on turnout side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Sleeper spacing inner-most side on turnout side after HOC
					For 1 Degree Curve			**For 2 Degree Curve**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
70	550	38029	550	38099	550.0	38132.3		550.0	38166.1	
71	550	38579	550	38649	550.0	38682.3		550.0	38716.1	
72	550	39129	550	39199	550.0	39232.3	550.0	550.0	39266.1	550.0
73	550	39679	550	39749	550.0	39782.3	550.0	550.0	39816.1	550.0
74	550	40229	550	40299	550.5	40332.8	549.5	551.1	40367.2	548.9
75	550	40779	550	40849	550.5	40883.4	549.5	551.1	40918.2	548.9
76	550	41329	550	41399	550.5	41433.9	549.5	551.1	41469.3	548.9
77	550	41879	550	41949	550.6	41984.5	549.4	551.1	42020.4	548.9
78	550	42429	550	42499	550.6	42535.1	549.4	551.1	42571.6	548.9
79	550	42979	550	43049	550.6	43085.6	549.4	551.1	43122.7	548.9
80	550	43529	550	43599	550.6	43636.2	549.4	551.2	43673.9	548.8
81	550	44079	550	44149	550.6	44186.8	549.4	551.2	44225.0	548.8
82	550	44629	550	44699	550.6	44737.4	549.4	551.2	44776.2	548.8
83	550	45179	550	45249	550.6	45288.0	549.4	551.2	45327.4	548.8

Annexure - 7

Sleeper spacing for 1 in 12 Thick Web Switch for different curvature for Contrary Flexure Layout: A side is one where crossing lies

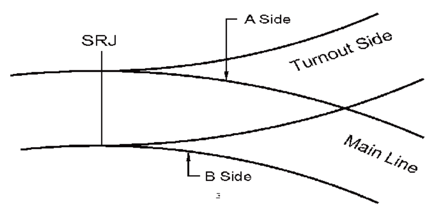
Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ ('A' side)	Sleeper spacing i.e. other than crossing side on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	150	150	150	150	149.9	149.9		149.7	149.7		149.6	149.6		149.4	149.4		149.3	149.3	
2	457	607	457	607	456.6	606.4		456.1	605.8		455.7	605.3		455.3	604.7		454.8	604.1	
3	505	1112	505	1112	504.5	1110.9		504.0	1109.9		503.6	1108.8		503.1	1107.8		502.6	1106.7	
4	745	1857	745	1857	744.3	1855.2		743.6	1853.5		742.9	1851.7		742.2	1849.9		741.4	1848.1	
5	492	2349	492	2349	491.5	2346.8		491.1	2344.5		490.6	2342.3		490.1	2340.0		489.7	2337.8	
6	550	2899	550	2899	549.5	2896.2		548.9	2893.5		548.4	2890.7		547.9	2887.9		547.4	2885.2	
7	550	3449	550	3449	549.5	3445.7		548.9	3442.4		548.4	3439.1		547.9	3435.8		547.4	3432.6	
8	550	3999	550	3999	549.5	3995.2		548.9	3991.4		548.4	3987.5		547.9	3983.7		547.4	3979.9	
9	550	4549	550	4549	549.5	4544.7		548.9	4540.3		548.4	4536.0		547.9	4531.6		547.4	4527.3	
10	550	5099	550	5099	549.5	5094.1		548.9	5089.3		548.4	5084.4		547.9	5079.5		547.4	5074.7	
11	550	5649	550	5649	549.5	5643.6		548.9	5638.2		548.4	5632.8		547.9	5627.4		547.4	5622.1	
12	550	6199	550	6199	549.5	6193.1		548.9	6187.2		548.4	6181.2		547.9	6175.3		547.4	6169.4	
13	550	6749	550	6749	549.5	6742.6		548.9	6736.1		548.4	6729.7		547.9	6723.2		547.4	6716.8	
14	550	7299	550	7299	549.5	7292.0		548.9	7285.1		548.4	7278.1		547.9	7271.1		547.4	7264.2	
15	550	7849	550	7849	549.5	7841.5		548.9	7834.0		548.4	7826.5		547.9	7819.0		547.4	7811.6	
16	550	8399	550	8399	549.5	8391.0		548.9	8383.0		548.4	8374.9		547.9	8366.9		547.4	8358.9	
17	550	8949	550	8949	549.5	8940.4		548.9	8931.9		548.4	8923.4		547.9	8914.8		547.4	8906.3	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ ('A' side)	Sleeper spacing i.e. other than crossing side on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
18	550	9499	550	9499	549.5	9489.9		548.9	9480.9		548.4	9471.8		547.9	9462.7		547.4	9453.7	
19	550	10049	550	10049	549.5	10039.4		548.9	10029.8		548.4	10020.2		547.9	10010.6		547.4	10001.1	
20	550	10599	550	10599	549.5	10588.9		548.9	10578.8		548.4	10568.6		547.9	10558.5		547.4	10548.5	
21	526	11125	549.79	11148.79	549.3	11138.2		548.8	11127.5		548.3	11116.9		548.1	11106.7		547.3	11095.7	
22	549	11674	550.04	11698.83	549.5	11687.7		549.0	11676.5		548.5	11665.4		548.0	11654.6		547.4	11643.2	
23	549	12223	550.04	12248.87	549.5	12237.2		549.0	12225.5		548.5	12213.9		548.0	12202.6		547.4	12190.6	
24	549	12772	550.04	12798.91	549.5	12786.7		549.0	12774.5		548.5	12762.3		548.0	12750.6		547.4	12738.0	
25	549	13321	550.04	13348.95	549.5	13336.2		549.0	13323.5		548.5	13310.8		548.0	13298.5		547.4	13285.4	
26	549	13870	550.04	13898.99	549.5	13885.7		549.0	13872.5		548.5	13859.3		548.0	13846.5		547.4	13832.9	
27	549	14419	550.04	14449.03	549.5	14435.3		549.0	14421.5		548.5	14407.7		548.0	14394.4		547.4	14380.3	
28	549	14968	550.04	14999.07	549.5	14984.8		549.0	14970.5		548.5	14956.2		548.0	14942.4		547.4	14927.7	
29	549	15517	550.04	15549.11	549.5	15534.3		549.0	15519.5		548.5	15504.7		548.0	15490.4		547.4	15475.1	
30	549	16066	550.04	16099.15	549.5	16083.8		549.0	16068.5		548.5	16053.1		548.0	16038.3		547.4	16022.5	
31	549	16615	550.04	16649.20	549.5	16633.3		549.0	16617.5		548.5	16601.6		548.0	16586.3		547.4	16570.0	
32	549	17164	550.04	17199.24	549.5	17182.8		549.0	17166.5		548.5	17150.1		548.0	17134.3		547.4	17117.4	
33	549	17713	550.04	17749.28	549.5	17732.4		549.0	17715.4		548.5	17698.6		548.0	17682.2		547.4	17664.8	
34	549	18262	550.04	18299.32	549.5	18281.9		549.0	18264.4		548.5	18247.0		548.0	18230.2		547.4	18212.2	
35	549	18811	550.04	18849.36	549.5	18831.4		549.0	18813.4		548.5	18795.5		548.0	18778.2		547.4	18759.7	
36	549	19360	550.04	19399.40	549.5	19380.9		549.0	19362.4		548.5	19344.0		548.0	19326.1		547.4	19307.1	
37	548	19908	549.04	19948.44	548.5	19929.4		548.0	19910.4		547.5	19891.4		547.0	19873.1		546.4	19853.5	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ ('A' side)	Sleeper spacing i.e. other than crossing side on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
38	549	20457	550.04	20498.48	549.5	20478.9		549.0	20459.4		548.5	20439.9		548.0	20421.0		547.4	20400.9	
39	549	21006	550.04	21048.52	549.5	21028.4		549.0	21008.4		548.5	20988.4		548.0	20969.0		547.4	20948.4	
40	549	21555	550.04	21598.56	549.5	21578.0		549.0	21557.4		548.5	21536.8		548.0	21517.0		547.4	21495.8	
41	549	22104	550.04	22148.60	549.5	22127.5		549.0	22106.4		548.5	22085.3		548.0	22064.9		547.4	22043.2	
42	549	22653	550.04	22698.65	549.5	22677.0		549.0	22655.4		548.5	22633.8		548.0	22612.9		547.4	22590.6	
43	549	23202	550.04	23248.69	549.5	23226.5		549.0	23204.4		548.5	23182.2		548.0	23160.9		547.4	23138.0	
44	549	23751	550.04	23798.73	549.5	23776.0		549.0	23753.4		548.5	23730.7		548.0	23708.8		547.4	23685.5	
45	549	24300	550.04	24348.77	549.5	24325.5		549.0	24302.3		548.5	24279.2		548.0	24256.8		547.4	24232.9	
46	549	24849	550.04	24898.81	549.5	24875.1		549.0	24851.3		548.5	24827.6		548.0	24804.8		547.4	24780.3	
47	549	25398	550.04	25448.85	549.5	25424.6		549.0	25400.3		548.5	25376.1		548.0	25352.7		547.4	25327.7	
48	549	25947	550.04	25998.89	549.5	25974.1		549.0	25949.3		548.5	25924.6		548.0	25900.7		547.4	25875.2	
49	549	26496	550.04	26548.94	549.5	26523.6		549.0	26498.3		548.5	26473.0		548.0	26448.6		547.4	26422.6	
50	549	27045	550.04	27098.98	549.5	27073.1		549.0	27047.3		548.5	27021.5		548.0	26996.6		547.4	26970.0	
51	549	27594	550.04	27649.02	549.5	27622.6		549.0	27596.3		548.5	27570.0		548.0	27544.6		547.4	27517.4	
52	549	28143	550.04	28199.06	549.5	28172.2		549.0	28145.3		548.5	28118.4		548.0	28092.5		547.4	28064.8	
53	549	28692	550.04	28749.10	549.5	28721.7		549.0	28694.3		548.5	28666.9		548.0	28640.5		547.4	28612.3	
54	549	29241	550.04	29299.14	549.5	29271.2		549.0	29243.3		548.5	29215.4		548.0	29188.5		547.4	29159.7	
55	549	29790	550.04	29849.18	549.5	29820.7		549.0	29792.3		548.5	29763.9		548.0	29736.4		547.4	29707.1	
56	549	30339	550.04	30399.22	549.5	30370.2		549.0	30341.3		548.5	30312.3		548.0	30284.4		547.4	30254.5	
57	549	30888	550.04	30949.26	549.5	30919.7		549.0	30890.2		548.5	30860.8		548.0	30832.4		547.4	30802.0	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ ('A' side)	Sleeper spacing i.e. other than crossing side on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
58	549	31437	550.04	31499.30	549.5	31469.3		549.0	31439.2		548.5	31409.3		548.0	31380.3		547.4	31349.4	
59	549	31986	550.04	32049.34	549.5	32018.8		549.0	31988.2		548.5	31957.7		548.0	31928.3		547.4	31896.8	
60	549	32535	550.04	32599.39	549.5	32568.3		549.0	32537.2		548.5	32506.2		548.0	32476.2		547.4	32444.2	
61	548	33083	549.04	33148.42	548.5	33116.8		548.0	33085.2		547.5	33053.7		547.0	33023.2		546.4	32990.6	
62	549	33632	550.04	33698.47	549.5	33666.3		549.0	33634.2		548.5	33602.1		548.0	33571.2		547.4	33538.1	
63	549	34181	550.04	34248.51	549.5	34215.8		549.0	34183.2		548.5	34150.6		548.0	34119.1		547.4	34085.5	
64	549	34730	550.04	34798.55	549.5	34765.3		549.0	34732.2		548.5	34699.1		548.0	34667.1		547.4	34632.9	
65	549	35279	550.04	35348.59	549.5	35314.9		549.0	35281.2		548.5	35247.5		548.0	35215.1		547.4	35180.3	
66	550	35829	550.00	35898.59	550	35864.9		550.0	35831.2		550.0	35797.5		550.0	35765.1		550.0	35730.3	
67	550	36379	550.00	36448.59	550	36414.9		550.0	36381.2		550.0	36347.5		550.0	36315.1		550.0	36280.3	
68	550	36929	550.00	36998.59	550	36964.9		550.0	36931.2		550.0	36897.5		550.0	36865.1		550.0	36830.3	
69	550	37479	550.00	37548.58	550	37514.9		550.0	37481.2		550.0	37447.5		550.0	37415.1		550.0	37380.3	
70	550	38029	550.00	38098.58	550	38064.9		550.0	38031.2		550.0	37997.5		550.0	37965.1		550.0	37930.3	
71	550	38579	550.00	38648.58	550	38614.9		550.0	38581.2		550.0	38547.5		550.0	38515.1		550.0	38480.3	
72	550	39129	550.00	39198.58	550	39164.9		550.0	39131.2		550.0	39097.5		550.0	39065.1		550.0	39030.3	
73	550	39679	550.00	39748.58	550	39714.9		550.0	39681.2		550.0	39647.5		550.0	39615.1		550.0	39580.3	
74	550	40229	550.00	40298.58	549.5	40264.3	550.5	548.9	40230.1	551.1	548.4	40195.9	551.6	547.9	40162.9	552.1	547.3	40127.7	
75	550	40779	550.00	40848.58	549.5	40813.8	550.5	548.9	40779.0	551.1	548.4	40744.3	551.6	547.8	40710.8	552.2	547.3	40675.0	
76	550	41329	550.00	41398.58	549.5	41363.2	550.5	548.9	41327.9	551.1	548.4	41292.7	551.6	547.8	41258.6	552.2	547.3	41222.3	
77	550	41879	550.00	41948.58	549.4	41912.7	550.6	548.9	41876.8	551.1	548.3	41841.0	551.7	547.8	41806.4	552.2	547.2	41769.5	

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies (A side)	Cumulative distance from SRJ ('A' side)	Sleeper spacing i.e. other than crossing side on main line for T/O taking off from straight as calculated using basic principles (B side)	Cumulative distance from SRJ using basic principles (B side)	Sleeper spacing (B side)	Cumulative distance from SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC	Sleeper spacing (B side)	Cumulative distance fom SRJ (B side)	Outer-most of t/o side after HOC
					For 1 Degree Curve			**For 2 Degree Curve**			**For 3 Degree Curve**			**For 4 Degree Curve**			**For 5 Degree Curve**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
78	550	42429	550.00	42498.58	549.4	42462.1	550.6	548.9	42425.7	551.1	548.3	42389.3	551.7	547.8	42354.1	552.2	547.2	42316.7	
79	550	42979	550.00	43048.58	549.4	43011.6	550.6	548.9	42974.6	551.1	548.3	42937.6	551.7	547.7	42901.9	552.3	547.2	42863.9	
80	550	43529	550.00	43598.58	549.4	43561.0	550.6	548.8	43523.4	551.2	548.3	43485.9	551.7	547.7	43449.6	552.3	547.1	43411.0	552.9
81	550	44079	550.00	44148.58	549.4	44110.4	550.6	548.8	44072.3	551.2	548.3	44034.2	551.7	547.7	43997.2	552.3	547.1	43958.1	552.9
82	550	44629	550.00	44698.58	549.4	44659.8	550.6	548.8	44621.1	551.2	548.2	44582.4	551.8	547.6	44544.9	552.4	547.1	44505.1	552.9
83	550	45179	550.00	45248.58	549.4	45209.2	550.6	548.8	45169.9	551.2	548.2	45130.6	551.8	547.6	45092.5	552.4	547.0	45052.2	553.0



CONTRARY FLEXURE

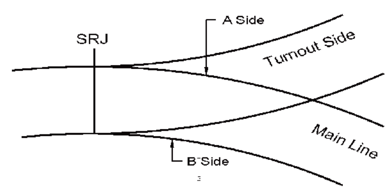
Annexure - 8

Sleeper spacing for 1 in 8.5 Over Riding Switch different curvature for Contrary Flexure : 'A' side is one where crossing lies

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies ('A' side)	Cumulative distance from SRJ (A side)	Sleeper spacing on main line for T/O taking off from straight ('B' side)	Cumulative distance from SRJ straight (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	268	268	268.0	268.0	268.0		268.0	268.0		268.0	268.0		268.0	268.0		268.0	268.0		268.0
2	600	868	600.0	868.0	600.0		868.0	600.0		868.0	600.0		868.0	600.0		868.0	600.0		868.0
3	605	1473	605.0	1473.0	605.0		1473.0	605.0		1473.0	605.0		1473.0	605.0		1473.0	605.0		1473.0
4	695	2168	695.0	2168.0	695.0		2168.0	695.0		2168.0	695.0		2168.0	695.0		2168.0	695.0		2168.0
5	605	2773	605.0	2773.0	605.0		2773.0	605.0		2773.0	605.0		2773.0	605.0		2773.0	605.0		2773.0
6	660	3433	660.0	3433.0	660.0		3433.0	660.0		3433.0	660.0		3433.0	660.0		3433.0	660.0		3433.0
7	600	4033	600.0	4033.0	600.0		4033.0	600.0		4033.0	600.0		4033.0	600.0		4033.0	600.0		4033.0
8	600	4633	600.0	4633.0	600.0		4633.0	600.0		4633.0	600.0		4633.0	600.0		4633.0	600.0		4633.0
9	600	5233	600.0	5233.0	600.0		5233.0	600.0		5233.0	600.0		5233.0	600.0		5233.0	600.0		5233.0
10	600	5833	600.0	5833.0	600.0		5833.0	600.0		5833.0	600.0		5833.0	600.0		5833.0	600.0		5833.0
11	600	6433	600.0	6433.0	600.0		6433.0	600.0		6433.0	600.0		6433.0	600.0		6433.0	600.0		6433.0
12	600	7033	600.0	7033.0	600.0		7033.0	600.0		7033.0	600.0		7033.0	600.0		7033.0	600.0		7033.0
13	600	7633	600.0	7633.0	600.0		7633.0	600.0		7633.0	600.0		7633.0	600.0		7633.0	600.0		7633.0
14	564	8197	599.6	8232.6	591.7		8224.7	583.9		8216.9	576.1		8209.1	568.3		8201.3	560.5		8193.5
15	597	8794	599.2	8831.7	598.6		8823.3	598.0		8814.9	597.4		8806.5	596.9		8798.2	596.3		8789.8
16	598	9392	600.2	9431.9	599.6		9422.9	599.0		9413.9	598.4		9405.0	597.9		9396.0	597.3		9387.1
17	598	9990	600.2	10032.0	599.6		10022.4	599.0		10012.9	598.4		10003.4	597.9		9993.9	597.3		9984.4
18	598	10588	600.2	10632.2	599.6		10622.0	599.0		10611.9	598.4		10601.9	597.9		10591.8	597.3		10581.7
19	597	11185	599.2	11231.3	598.6		11220.6	598.0		11210.0	597.4		11199.3	596.9		11188.7	596.3		11178.0

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies ('A' side)	Cumulative distance from SRJ (A side)	Sleeper spacing on main line for T/O taking off from straight ('B' side)	Cumulative distance from SRJ straight (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)
					For 1 Degree Curve			**For 2 Degree Curve**			**For 3 Degree Curve**			**For 4 Degree Curve**			**For 5 Degree Curve**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
20	598	11783	600.2	11831.5	599.6		11820.2	599.0		11809.0	598.4		11797.7	597.9		11786.5	597.3		11775.3
21	598	12381	600.2	12431.6	599.6		12419.8	599.0		12408.0	598.4		12396.2	597.9		12384.4	597.3		12372.6
22	598	12979	600.2	13031.8	599.6		13019.4	599.0		13007.0	598.4		12994.6	597.9		12982.3	597.3		12969.9
23	597	13576	599.2	13630.9	598.6		13617.9	598.0		13605.0	597.4		13592.1	596.9		13579.1	596.3		13566.2
24	598	14174	600.2	14231.1	599.6		14217.5	599.0		14204.0	598.4		14190.5	597.9		14177.0	597.3		14163.5
25	598	14772	600.2	14831.3	599.6		14817.1	599.0		14803.0	598.4		14789.0	597.9		14774.9	597.3		14760.8
26	598	15370	600.2	15431.4	599.6		15416.7	599.0		15402.0	598.4		15387.4	597.9		15372.8	597.3		15358.1
27	597	15967	599.2	16030.6	598.6		16015.3	598.0		16000.0	597.4		15984.8	596.9		15969.6	596.3		15954.4
28	598	16565	600.2	16630.7	599.6		16614.8	599.0		16599.1	598.4		16583.3	597.9		16567.5	597.3		16551.7
29	598	17163	600.2	17230.9	599.6		17214.4	599.0		17198.1	598.4		17181.7	597.9		17165.4	597.3		17149.0
30	598	17761	600.2	17831.0	599.6		17814.0	599.0		17797.1	598.4		17780.2	597.9		17763.2	597.3		17746.3
31	597	18358	599.2	18430.2	598.6		18412.6	598.0		18395.1	597.4		18377.6	596.9		18360.1	596.3		18342.6
32	598	18956	600.2	19030.4	599.6		19012.2	599.0		18994.1	598.4		18976.0	597.9		18958.0	597.3		18939.9
33	598	19554	600.2	19630.5	599.6		19611.8	599.0		19593.1	598.4		19574.5	597.9		19555.9	597.3		19537.2
34	598	20152	600.2	20230.7	599.6		20211.3	599.0		20192.1	598.4		20172.9	597.9		20153.7	597.3		20134.5
35	597	20749	599.2	20829.8	598.6		20809.9	598.0		20790.1	597.4		20770.4	596.9		20750.6	596.3		20730.9
36	598	21347	600.2	21430.0	599.6		21409.5	599.0		21389.1	598.4		21368.8	597.9		21348.5	597.3		21328.2
37	598	21945	600.2	22030.1	599.6		22009.1	599.0		21988.2	598.4		21967.2	597.9		21946.3	597.3		21925.5
38	598	22543	600.2	22630.3	599.6		22608.7	599.0		22587.2	598.4		22565.7	597.9		22544.2	597.3		22522.8
39	597	23140	599.2	23229.5	598.6		23207.2	598.0		23185.2	597.4		23163.1	596.9		23141.1	596.3		23119.1
40	598	23738	600.2	23829.6	599.6		23806.8	599.0		23784.2	598.4		23761.6	597.9		23739.0	597.3		23716.4
41	598	24336	600.2	24429.8	599.6		24406.4	599.0		24383.2	598.4		24360.0	597.9		24336.8	597.3		24313.7

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies ('A' side)	Cumulative distance from SRJ (A side)	Sleeper spacing on main line for T/O taking off from straight ('B' side)	Cumulative distance from SRJ straight (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer most sl spacing on t/o side for xing sleeper after 48th sleeper	Cumulative distance from SRJ (B side)
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
42	598	24934	600.2	25029.9	599.6		25006.0	599.0		24982.2	598.4		24958.4	597.9		24934.7	597.3		24911.0
43	550	25484	550.0	25579.9	550.0		25556.0	550.0		25532.2	550.0		25508.4	550.0		25484.7	550.0		25461.0
44	550	26034	550.0	26129.9	550.0		26106.0	550.0		26082.2	550.0		26058.4	550.0		26034.7	550.0		26011.0
45	550	26584	550.0	26679.9	550.0		26656.0	550.0		26632.2	550.0		26608.4	550.0		26584.7	550.0		26561.0
46	550	27134	550.0	27229.9	550.0		27206.0	550.0		27182.2	550.0		27158.4	550.0		27134.7	550.0		27111.0
47	550	27684	550.0	27779.9	550.0	550.0	27756.0	550.0	550.0	27732.2	550.0	550.0	27708.4	550.0	550.0	27684.7	550.0	550.0	27661.0
48	550	28234	550.0	28329.9	550.0	550.0	28306.0	550.0	550.0	28282.2	550.0	550.0	28258.4	550.0	550.0	28234.7	550.0	550.0	28211.0
49	550	28784	550.0	28879.9	549.5	550.5	28855.5	548.6	551.4	28830.8	547.9	552.1	28806.4	547.2	552.8	28781.9	546.5	553.5	28757.5
50	550	29334	550.0	29429.9	549.5	550.5	29404.9	548.3	551.7	29379.1	547.4	552.6	29353.7	546.5	553.5	29328.4	545.7	554.3	29303.2
51	550	29884	550.0	29979.9	549.4	550.6	29954.3	547.9	552.1	29927.0	546.9	553.1	29900.6	545.8	554.2	29874.3	544.8	555.2	29848.0
52	550	30434	550.0	30529.9	549.4	550.6	30503.8	547.6	552.4	30474.6	546.4	553.6	30447.0	545.2	554.8	30419.5	544.0	556.0	30391.9
53	550	30984	550.0	31079.9	549.4	550.6	31053.2	547.2	552.8	31021.8	545.9	554.1	30992.9	544.5	555.5	30963.9	543.1	556.9	30935.1
54	550	31534	550.0	31629.9	549.4	550.6	31602.6	546.9	553.1	31568.7	545.3	554.7	31538.2	543.8	556.2	31507.7	542.3	557.7	31477.3



CONTRARY FLEXURE

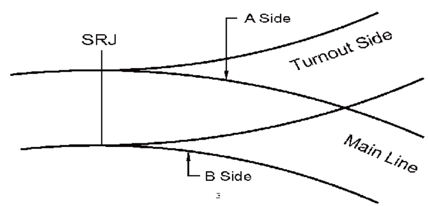
Annexure - 9

Sleeper spacing for 1 in 8.5 Thick Web Switch for different curvature for Contrary Flexure layout: 'A' side is one where crossing lies

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies ('A' side)	Cumulative distance from SRJ (A side)	Sleeper spacing i.e. other than crossing side on main line for T/O taking off from straight (B side)	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most sleeper spaces on t/o side after HOC	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side after HOC	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side 4 deg	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side 5 deg after HOC	Cumulative distance from SRJ (B side)
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	268	268	268	268	267.7		267.7	267.5		267.5	267.2		267.2	267.0		267.0	266.7		266.7
2	600	868	600	868	599.4		867.2	598.9		866.3	598.3		865.5	597.7		864.7	597.1		863.9
3	605	1473	605	1473	604.4		1471.6	603.8		1470.2	603.3		1468.8	602.7		1467.4	602.1		1466.0
4	695	2168	695	2168	694.3		2165.9	693.7		2163.9	693.0		2161.8	692.3		2159.7	691.7		2157.7
5	605	2773	605	2773	604.4		2770.4	603.8		2767.7	603.3		2765.1	602.7		2762.4	602.1		2759.8
6	660	3433	660	3433	659.4		3429.7	658.7		3426.4	658.1		3423.2	657.5		3419.9	656.9		3416.6
7	600	4033	600	4033	599.4		4029.1	598.9		4025.3	598.3		4021.4	597.7		4017.6	597.1		4013.8
8	600	4633	600	4633	599.4		4628.6	598.9		4624.2	598.3		4619.7	597.7		4615.3	597.1		4610.9
9	600	5233	600	5233	599.4		5228.0	598.9		5223.0	598.3		5218.0	597.7		5213.0	597.1		5208.0
10	600	5833	600	5833	599.4		5827.4	598.9		5821.9	598.3		5816.3	597.7		5810.7	597.1		5805.2
11	600	6433	600	6433	599.4		6426.9	598.9		6420.7	598.3		6414.6	597.7		6408.4	597.1		6402.3
12	600	7033	600	7033	599.4		7026.3	598.9		7019.6	598.3		7012.9	597.7		7006.2	597.1		6999.5
13	600	7633	600	7633	599.4		7625.7	598.9		7618.4	598.3		7611.1	597.7		7603.9	597.1		7596.6
14	564	8197	599.6	8232.55	599.0		8224.7	598.5		8216.9	597.9		8209.1	597.4		8201.3	596.9		8193.5
15	597	8794	599.2	8831.7	598.6		8823.3	598.0		8814.9	597.4		8806.5	596.9		8798.2	596.3		8789.8
16	598	9392	600.2	9431.9	599.6		9422.9	599.0		9413.9	598.4		9405.0	597.9		9396.0	597.3		9387.1
17	598	9990	600.2	10032.0	599.6		10022.4	599.0		10012.9	598.4		10003.4	597.9		9993.9	597.3		9984.4
18	598	10588	600.2	10632.2	599.6		10622.0	599.0		10611.9	598.4		10601.9	597.9		10591.8	597.3		10581.7
19	597	11185	599.2	11231.3	598.6		11220.6	598.0		11210.0	597.4		11199.3	596.9		11188.7	596.3		11178.0

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies ('A' side)	Cumulative distance from SRJ (A side)	Sleeper spacing i.e. other than crossing side on main line for T/O taking off from straight (B side)	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most sleeper spaces on t/o side after HOC	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side after HOC	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side 4 deg	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side 5 deg after HOC	Cumulative distance from SRJ (B side)
					For 1 Degree Curve			**For 2 Degree Curve**			**For 3 Degree Curve**			**For 4 Degree Curve**			**For 5 Degree Curve**		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
20	598	11783	600.2	11831.5	599.6		11820.2	599.0		11809.0	598.4		11797.7	597.9		11786.5	597.3		11775.3
21	598	12381	600.2	12431.6	599.6		12419.8	599.0		12408.0	598.4		12396.2	597.9		12384.4	597.3		12372.6
22	598	12979	600.2	13031.8	599.6		13019.4	599.0		13007.0	598.4		12994.6	597.9		12982.3	597.3		12969.9
23	597	13576	599.2	13630.9	598.6		13617.9	598.0		13605.0	597.4		13592.1	596.9		13579.1	596.3		13566.2
24	598	14174	600.2	14231.1	599.6		14217.5	599.0		14204.0	598.4		14190.5	597.9		14177.0	597.3		14163.5
25	598	14772	600.2	14831.3	599.6		14817.1	599.0		14803.0	598.4		14789.0	597.9		14774.9	597.3		14760.8
26	598	15370	600.2	15431.4	599.6		15416.7	599.0		15402.0	598.4		15387.4	597.9		15372.8	597.3		15358.1
27	597	15967	599.2	16030.6	598.6		16015.3	598.0		16000.0	597.4		15984.8	596.9		15969.6	596.3		15954.4
28	598	16565	600.2	16630.7	599.6		16614.8	599.0		16599.1	598.4		16583.3	597.9		16567.5	597.3		16551.7
29	598	17163	600.2	17230.9	599.6		17214.4	599.0		17198.1	598.4		17181.7	597.9		17165.4	597.3		17149.0
30	598	17761	600.2	17831.0	599.6		17814.0	599.0		17797.1	598.4		17780.2	597.9		17763.2	597.3		17746.3
31	597	18358	599.2	18430.2	598.6		18412.6	598.0		18395.1	597.4		18377.6	596.9		18360.1	596.3		18342.6
32	598	18956	600.2	19030.4	599.6		19012.2	599.0		18994.1	598.4		18976.0	597.9		18958.0	597.3		18939.9
33	598	19554	600.2	19630.5	599.6		19611.8	599.0		19593.1	598.4		19574.5	597.9		19555.9	597.3		19537.2
34	598	20152	600.2	20230.7	599.6		20211.3	599.0		20192.1	598.4		20172.9	597.9		20153.7	597.3		20134.5
35	597	20749	599.2	20829.8	598.6		20809.9	598.0		20790.1	597.4		20770.4	596.9		20750.6	596.3		20730.9
36	598	21347	600.2	21430.0	599.6		21409.5	599.0		21389.1	598.4		21368.8	597.9		21348.5	597.3		21328.2
37	598	21945	600.2	22030.1	599.6		22009.1	599.0		21988.2	598.4		21967.2	597.9		21946.3	597.3		21925.5
38	598	22543	600.2	22630.3	599.6		22608.7	599.0		22587.2	598.4		22565.7	597.9		22544.2	597.3		22522.8
39	597	23140	599.2	23229.5	598.6		23207.2	598.0		23185.2	597.4		23163.1	596.9		23141.1	596.3		23119.1
40	598	23738	600.2	23829.6	599.6		23806.8	599.0		23784.2	598.4		23761.6	597.9		23739.0	597.3		23716.4

Sleeper no.	Distance between sleeper as per RDSO drg on a side where xing lies ('A' side)	Cumulative distance from SRJ (A side)	Sleeper spacing i.e. other than crossing side on main line for T/O taking off from straight (B side)	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most sleeper spaces on t/o side after HOC	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side after HOC	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side 4 deg	Cumulative distance from SRJ (B side)	Sleeper spacing (B side)	Outer-most of t/o side 5 deg after HOC	Cumulative distance from SRJ (B side)
					For 1 Degree Curve			For 2 Degree Curve			For 3 Degree Curve			For 4 Degree Curve			For 5 Degree Curve		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
41	598	24336	600.2	24429.8	599.6		24406.4	599.0		24383.2	598.4		24360.0	597.9		24336.8	597.3		24313.7
42	598	24934	600.2	25029.9	599.6		25006.0	599.0		24982.2	598.4		24958.4	597.9		24934.7	597.3		24911.0
43	550	25484	550.0	25579.9	550.0		25556.0	550.0		25532.2	550.0		25508.4	550.0		25484.7	550.0		25461.0
44	550	26034	550.0	26129.9	550.0		26106.0	550.0		26082.2	550.0		26058.4	550.0		26034.7	550.0		26011.0
45	550	26584	550.0	26679.9	550.0		26656.0	550.0		26632.2	550.0		26608.4	550.0		26584.7	550.0		26561.0
46	550	27134	550.0	27229.9	550.0		27206.0	550.0		27182.2	550.0		27158.4	550.0		27134.7	550.0		27111.0
47	550	27684	550.0	27779.9	550.0	550.0	27756.0	550.0	550.0	27732.2	550.0	550.0	27708.4	550.0	550.0	27684.7	550.0	550.0	27661.0
48	550	28234	550.0	28329.9	550.0	550.0	28306.0	550.0	550.0	28282.2	550.0	550.0	28258.4	550.0	550.0	28234.7	550.0	550.0	28211.0
49	550	28784	550.0	28879.9	549.5	550.5	28855.5	548.6	551.4	28830.8	547.9	552.1	28806.4	547.2	552.8	28781.9	546.5	553.5	28757.5
50	550	29334	550.0	29429.9	549.5	550.5	29404.9	548.3	551.7	29379.1	547.4	552.6	29353.7	546.5	553.5	29328.4	545.7	554.3	29303.2
51	550	29884	550.0	29979.9	549.4	550.6	29954.3	547.9	552.1	29927.0	546.9	553.1	29900.6	545.8	554.2	29874.3	544.8	555.2	29848.0
52	550	30434	550.0	30529.9	549.4	550.6	30503.8	547.6	552.4	30474.6	546.4	553.6	30447.0	545.2	554.8	30419.5	544.0	556.0	30391.9
53	550	30984	550.0	31079.9	549.4	550.6	31053.2	547.2	552.8	31021.8	545.9	554.1	30992.9	544.5	555.5	30963.9	543.1	556.9	30935.1
54	550	31534	550.0	31629.9	549.4	550.6	31602.6	546.9	553.1	31568.7	545.3	554.7	31538.2	543.8	556.2	31507.7	542.3	557.7	31477.3



CONTRARY FLEXURE

ANNEXURE 10: SALIENT FEATURES OF VARIOUS TYPES OF BG TURNOUTS WITH CURVED SWITCH AND CMS CROSSINGS FOR USE ON FAN SHAPED PSC SLEEPERS

Rail Section	Type of Sleepers	Description of T/O. & Drg.No.	S.E.A.	Dr.No. of switch	Length of switch	Length of tongue rail	Radius of lead curve	Type of X-ing	Drg.No. of crossing	Length of X-ing	Length of TO assembly SJ to HOC along straight	Speed potential Kmph.	Remarks
52 Kg	PSC	1:8.5(BG) RT-4865	$0^0$46'59"	RT-4866	6400	11900	232320	CMS	RT-4867	3300	28511	25	Without reinforci-ng strap
60 Kg	PSC	1:8.5 RT-4865	$0^0$46'59"	RT-4966	6400	11900	232320	CMS	RT-4967	3300	28511	25	-do-
52 Kg	PSC	1:12 RT-4732	$0^0$20'00"	RT-4733	10125	12356	441360	CMS	RT-4734	4350	39975	50	-do
60 Kg	PSC	1:12 RT-4218	$0^0$20'00"	RT-4219	10125	12356	441360	CMS	RT-4220	4350	39975	50	-do
52 Kg (CR-	PSC	1:12 RT-5168	$0^0$20'00"	RT-5169	10125	12356	441360	CMS	RT-4734	4350	39975	50	-do

52 Kg (Assy)	PSC (Thick Web)	1:12 RT-5268 ZU-2-49	$0^0$20’00”	RT-5269	10125	12356	441360	CMS	RT-4734	4350	39975	50	-do
60 Kg (Assy)	PSC (Thick \Web)	1:12 RT-6154 ZU-1-60	$0^0$20’00”	RT-6155	10125	12356	441360	CMS	RT-4220	4350	39975	50	-do-
60 Kg	PSC	1:16 RT-5691	$0^0$20’00”	RT-5692	11200	12935	784993	CMS	RT-5693	5400	51582	66	-do-
60 Kg	PSC	1:20 RT-5858	$0^0$20’00”	RT-5859	12460	13000	1283100	CMS	RT-5860	6200	63924	85	-do-
52 Kg	PSC	1:8.5(BG) RT-5353	0^0 46’59”	RT-5354	6400	11900	464070	CMS	RT-4867	3300	28538	40	Without reinforcing strap
60 Kg	PSC	1:8.5 RT-5353	0^0 46’59”	RT-5354	6400	11900	464070	CMS	RT-4967	3300	28538	40	-do-
52 Kg	PSC	1:12 RT-5553	0^0 20’ 00”	RT-5554	10125	12356	882290	CMS	RT-4734	4350	39975	70	-do-
60 Kg	PSC	1:12 RT-5553	0^0 20’ 00”	RT-5554	10125	12356	882290	CMS	RT-4220	4350	39975	70	-do-

ANNEXURE 11 : IMPORTANT DIMENSIONS OF BG TURNOUTS WITH CURVED SWITCH

	1:8.5						1:12					
	90R		52Kg		60Kg		52Kg					
								On PSC Sleeper			On PSC Sleeper	
Notations	On Wooden/Steel Sleepers	On Psc Sleeper (Fan-shaped) Spacing	On Wooden/ Steel Sleepers	On Psc Sleepers (Fan-shapd Spacing)	On Wooden Sleepers	On Psc Sleepers (Fan-shaped Spacing)	On Wooden/ Steel Sleepers	On Psc Sleeper On Wooden/ Steel Sleepers	On Psc Sleepers (Conventional Spacing)	On Psc Sleepers (Fan-shaped Spacing)	On Psc Leepers (Perpen Dicularspacing)	On Psc Sleepers (Fan Shaped Spacing)
DRG. No	TA-20148 TA-20822	RDSO/T-4865	TA-20196 TA-20835	RDSO/ T-4865	RDSO/ T-3009	RDSO/ T-4865	TA-20171 TA-20831	EDO/T-1912	RDSO/ T-4732	RDSO/ T-2579	RDSO/ T-3776	RDSO/ T-4216
1	2	3	4	5	6	7	8	9	10	11	12	13
Z	18395	18395	18395	18395	18424	18395	27870	27870	25831	25831	25831	25831
Y	6835	6839	6835	6839	7135	6839	8478	7730	10125	10125	10125	10125
α	0°-47' -27"	0°-46'-59"	0°-47'-27"	0°-46'-59"	0°-35'-00"	0°-46'-39"	0°-27'-35"	0°-27'-35"	0°-20'-00"	0°-20'-00"	0°-20'-00"	0°-20'-00"

θ	6°-42'-35"	6°-42'-35"	6°-42'-35"	6°-42'-35"	6°-42'-35"	6°-42'-35"	4°-45'-49"	4°-45'-49"	4°-45'-49"	4°-45'-49"	4°-45'-49"	4°-45'-49"
S	18513	18514	18527	18527	18565	18536	28056	28056	26017	26029	26029	26029
T	6400	6400	6400	6400	7135	6400	7730	7730	10125	10125	10125	10125
R	232320	232260	232320	232260	231440	232260	458120	458120	441360	441360	441360	441360
X	182.5	182	182.5	182	182.5	182	133	133	175	175	175	175
Q	982	1076	996	1102	1021	1120	1418	1418	2063	2075	2075	2075
L	29502	28613	29516	28613	29516	28613	41004	41004	39975	41004	41004	39975
XING TYPE & LENGTH	BUILT-UP 5970	CMS 3300	BUILT-UP 4800	CMS 3300	BUILT-UP 4850	CMS 3300	BUILT-UP 5970	BUILT-UP 5970	CMS 4350	BUILT-UP 5970	BUILT-UP 5970	CMS 4350

ANNEXURE 12: IMPORTANT DIMENSIONS OF TURNOUTS (OTHER THAN BG) WITH CURVED SWITCHES

	1:8.5					1:12					1:12
	MG				NG	MG				NG	MG
	75 R		90R	52 kg	60R	75R		90R		60R	52 kg
Notations	Straight on wooden/ steel sleepers	Curved on wooden/ steel sleepers	Curved on wooden/ Steel Sleepers	Curved on wooden/ steel sleepers	Straight loose heel	Straight fixed heel	Partly curved fixed heel	Partly curved on wooden /steel sleepers	Partly curved on fan shaped PSC sleepers	Straight fixed heel	Curved PSC sleeper
Drg No.	TA-20404 TA-21004	TA-20451 TA-21019	TA-20497 TA-21025	RDSO /T-6327	TA-20604	TA-20401 TA-21001	TA-20464 TA-21016	TA-20494 TA-21022	RDSO/ T-4623	TA-20601	RDSO/ T-6450
1	2	3	4	5	6	7	8	9	10	11	12
Z	11560	9515	9515	9515	8280	16323	15108	14678	14678	11723	14678
Y	4320	6206	6206	6206	4320	5777	7544	7974	7974	5777	7974

α	1^0-35' -30"	0^0-29' -14"	0^0-29' -14"	0^0-29' -14"	1^0-35' -30"	1^0-9' -38"	0^0-24' -27"	0^0-24' -27"	0^0-24' -27"	1^0-9' -38"	0^0-24' -27"
θ	6^0-42' -35"	6^0-42' -35"	6^0-42' -35"	6^0-42' -35"	6^0-42' -35"	4^0-45' -49"	4^0-45' -49"	4^0-45' -49"	4^0-45' -49"	4^0-45' -49"	4^0-45' -49"
S	11672	9627	9633	9647	8375	16480	15265	14845	14846	11857	14864
T	4115	5500	5500	5500	4115	5485	6700	7130	7130	5485	7130
R	119610	-	-	-	82600	240604	-	-	-	167340	-
R1	-	130210	130210	130205	-	-	-	-	-	-	-
R2	-	-	-	-	-	-	258300	258300	258300	-	258310
X	120	169	169	169	120	117	117	130	130	117	130
Q	1027	1027	1033	1047	1010	1377	1377	1387	1387	1394	1405
L	19676	19676	19676	19918	16365	26495	26494	26502	25711	21861	25776
X-ing Type	BUILT UP	BUILT UP	BUILT UP	HTW XING	BUILT UP	BUILT UP	BUILT UP	BUILT UP	CMS	BUILT UP	CMS
Length	4800	4800	4800	4550	4800	4800	4800	4800	3550	4800	3550

ANNEXURE 13 : SPACING OF 1 IN 8.5 SYMMETRICAL SPLIT TURN OUT SLEEPERS

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
	268	
1		268
	600	
2		868
	605	
3		1473
	695	
4		2168
	605	
5		2773
	660	
6		3433
	600	
7		4033
	600	
8		4633
	600	
9		5233
	600	
10		5833
	600	
11		6433
	600	
12		7033
	600	
13		7633
	600	
14		8233
	600	
15		8833
	600	
16		9433
	580	
17		10013
	600	
18		10613
	600	
19		11213
	600	
20		11813
	600	
21		12413
	600	
22		13013
	600	
23		13613
	590	
24		14203
	600	
25		14803
	600	
26		15403
	600	
27		16003
	600	
28		16603
	600	
29		17203
	600	
30		17803
	600	
31		18403
	600	
32		19003
	590	
33		19593
	600	
34		20193
	600	
35		20793
	600	
36		21393
	600	
37		21993
	590	
38		22583
	600	
39		23183
	600	
40		23783
	600	
41		24383
	590	
42		24973
	517	
43		25490
	550	
44		26040
	550	
45		26590
	550	
46		27140

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
48		28240
	550	
49		28790
	550	
50		29340
	550	
51		29890
	550	
52		30440
	550	
53		30990
	550	
54		31540
	550	
47		27690
	550	

ANNEXURE 14 : SPACING OF 1 IN 12 SYMMETRICAL SPLIT TURN OUT SLEEPERS

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
	150	
1		150
	457	
2		607
	510	
3		1117
	695	
4		1812
	537	
5		2349
	550	
6		2899
	550	
7		3449
	550	
8		3999
	550	
9		4549
	550	
10		5099
	550	
11		5649
	550	
12		6199
	550	
13		6749
	550	
14		7299
	550	
15		7849
	550	
16		8399
	550	
17		8949
	550	
18		9499
	550	
19		10049
	550	
20		10599
	550	
21		11149
	550	
22		11699
	550	

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
23		12249
	550	
24		12799
	550	
25		13349
	550	
26		13899
	550	
27		14449
	540	
28		14989
	550	
29		15539
	550	
30		16089
	550	
31		16639
	550	
32		17189
	550	
33		17739
	550	
34		18289
	550	
35		18839
	550	
36		19389
	540	
37		19929
	550	
38		20479
	550	
39		21029
	550	
40		21579
	560	
41		22139
	550	
42		22689
	550	
43		23239
	550	
44		23789
	550	
45		24339

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
	550	
46		24889
	550	
47		25439
	550	
48		25989
	550	
49		26539
	550	
50		27089
	550	
51		27639
	550	
52		28189
	540	
53		28729
	550	
54		29279
	550	
55		29829
	550	
56		30379
	550	
57		30929
	550	
58		31479
	550	
59		32029
	550	
60		32579
	550	
61		33129
	550	
62		33679
	550	
63		34229
	540	
64		34769
	540	
65		35309
	541	
66		35850
	550	
67		36400
	550	
68		36950
	550	
69		37500

	Distance from SRJ	
Sleeper no	Individual spacing	cumulative
	550	
70		38050
	550	
71		38600
	550	
72		39150
	550	
73		39700
	550	
74		40250
	550	
75		40800
	550	
76		41350
	550	
77		41900
	550	
78		42450
	550	
79		43000
	550	
80		43550
	550	
81		44100
	550	
82		44650
	550	
83		45200

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Published by

Indian Railways Institute of Civil Engineering

11-A, South Main Road, Koregaon Park, Pune - 411001.